

**Technologies of Mettle:
The Acting Self and the Early Modern English Culture of Metals**

by

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Introduction

*Yet I,
A dull and muddy-mettled rascal, peak
Like John-a-dreams, unpregnant of my cause,
And can say nothing;
(Hamlet, Hamlet, 2.2.566-69)¹*

What does Hamlet's description of himself as "dull and muddy-mettled" have to do with his delay in fulfilling his "cause," avenging his father's murder? Hamlet complains that his "dull and muddy-mettle" makes him "peak" or mope about, "unpregnant of [his] cause," and "say nothing" (2.2.569) to his mother about the ghost of his father. In contrast to the young Fortinbras— whose efforts to avenge his own father's loss of life and property render him in Horatio's eyes as being of a "hot and full," albeit "unrefined mettle" (1.1.96)— Hamlet does not act on his impulse. Hamlet's contrast between his own muddy mettle and a visiting player's ability to emote in reaction to a fictional rendering of Hecuba's grief implicates mettle in much more than its commonplace meaning, a sense of spirited courage; rather, Hamlet's reaction to the player's ability to act on stage suggests that mettle is involved in action generally conceived. Moreover, that the action is rooted in Hamlet's muddy mettle and Fortinbras' hot, full, unrefined mettle imparts a material quality to an otherwise abstracted sense of spiritedness. The two adjectives used to describe their mettles—"muddy" and "unrefined"—point to a frequent double meaning of mettle-metal.

"Technologies of Mettle: The Acting Self and the Early Modern English Culture of Metals" takes into account the double meaning of mettle and metal to consider the

implications of describing the acting self in terms of the material world located outside the self. Mary Floyd-Wilson, in her recent article “English Mettle,” reads mettle through the intellectual historical lens of humoral and climate theory, similarly invoking the “materiality of human mettle” by asking how it is “akin to the durable substances that lie in the veins of the earth.”² Following Gail Kern Paster’s invocation of the “network of analogy” that allows “human passions [... to] take on an elemental force and character contingent upon a [...] set of correspondences between inner and outer worlds,”³ Floyd-Wilson asserts that mettle “has more than a metaphorical relationship to the elements of the natural world.”⁴ Paster’s analogy between the “forceful behaviors of minerals” and the “forceful behaviors in animate life,” most visible in the physiology of the spirits, is the correspondence between outer and inner worlds most relevant to both Floyd-Wilson and myself.⁵ But, whereas Floyd-Wilson finds mettle useful to describe ethnological distinctions in temperance derived from the humoral non-naturals of the environment and climate, including the quality of the ground and the minerals residing under it, I find mettle useful as a model of selfhood emerging from a pervasive English culture of metals comprised of the metallic arts of mining, metallurgy, alchemy, and chymistry.

Early modern cultural studies has approached the question of the self in terms of a number of discourses, most recently anatomy and Galenic and Paracelsian medicine.⁶ Studies such as Paster’s and Floyd-Wilson’s, which draw from Galenic humoral physiology, capture the interplay between the balancing-act of humors within the body through the primarily concoctive processes of eating and digestion and the effects of external, “non-natural” circumstances such as diet and climate on specific, humorally-determined dispositions.⁷ Responding to a recent call for models of embodiment outside

the realm of early modern medicine, which could be seen to present a hegemonic account of the self that does not take into account ethical or religious discourses,⁸ I consider the ways in which alternate models of selfhood that focus on the self in action can be mapped on to the humoral body. I take the fact that Hamlet and Fortinbras' mettles are described not in terms of humors, but in terms reserved for inanimate, mineral material located outside of the body, especially the refining of that material, as an indication that some other discourse is at work. My dissertation therefore builds upon the predominately medical and humoral account of the concoctive processes that organize the self by proposing a model of the self based on the metallic arts, a field that attempts to replicate the natural concoctive processes in the bowels of the earth in the artificial fires of a furnace. I therefore chart the macrocosmic, earthly corollary to the microcosmic ingestive and digestive control of the body through technologies of mettle. What I call the metallic arts—activities as diverse as mining, assaying, refining, and alchemy—share the sense that a craftsperson's will, in conjunction with his or her tacit knowledge of fire, acts upon a malleable and wielding matter; that matter, in turn, on account of its subterranean location, is legible only through a repertoire of signs and practices that engage the expert judgment of the artificer. The significance of the mineral referent to mettle is that it cannot be known without the intervention of the self through *techne* or technology. The technologies that allow metals to come to light are therefore the necessary precursors to the metaphorical uses of metals to describe the motivation to act, such as we find in *Hamlet* and many other literary works in the early modern period. The references to the refining and testing of mettle attest to the fact that the legibility of mettle relies not only on the mineral world, but on the metallic arts that bring that subterranean world to light.

The materiality of Hamlet and Fortinbras' mettles stems from a peculiarity in the sixteenth- and seventeenth- century etymologies of the word "mettle." Whereas "mettle" most often is understood as manly courage or spiritedness, the *Oxford English Dictionary* reveals a more complicated story that both complements and extends Floyd-Wilson's definition of mettle as "the physiological property that determines the initiation, experience, and duration of an impassioned state."⁹ I would argue that mettle is a fundamental part of the self comprising both substance and spirit and therefore responsible not simply for determining "impassioned state[s]," but for grounding the way in which the self acts in response to such states. "Mettle" was originally a variant of "metal," but in the sixteenth and seventeenth centuries, "mettle" referred both to the literal meaning of "metal" and the figurative meanings of the character (*OED* A.1), spirit (A.2), or "stuff" (A.1) out of which a person is made. During this period, the -le and -al endings were used inconsistently (sometimes within the same work) to signify the figurative sense of character, spirit, or "stuff." For example, Daniel Rogers' *Naaman, the Syrian, His Disease and Cure* (1642) contains the following two spellings: "To try the spirit of men, of what mettle they are made of"; and "Then she shewes the metall she is made of." A similar variation occurs in the quarto and folio editions of William Shakespeare's *I Henry IV*, when Prince Hal describes himself in the 1598 quarto edition as "a Corinthian, a lad of metall" and in the 1623 Folio as "a lad of mettle" (2.5.12). At times, the -le and -al endings were used to pun simultaneously on both literal and figurative senses. For example, in Thomas Dekker's *The Honest Whore* (1604), Mattheo, a friend of the Duke, wishes the Duke had "so much mettle in him, as in a cobblers awle"

(1.1.78). The use of “mettle” here refers to the dearth of character implied by the small amount of actual metal contained in an awl. The *OED* describes this example as a pun between not two words, but two senses of the same word.¹⁰ Based in part on this etymology, I suggest that the metallic arts, which describe their domain of knowledge in terms of human will exerting itself on the matter of the earth, can provide new understandings about the early modern acting self. That is not to say that every reference to metal, regardless of context, necessarily referred to mettle; rather, the etymological blurring in the sixteenth and seventeenth centuries resonates with instances in literature when metaphors derived from metallic technologies are used in conjunction with non-material, or human, subjects.

The literary invocation of “mettle” to describe the “stuff” and spirit of a person underscores the analogy that Paster cites between metals and the Galenic physiology of the spirits, the early modern explanation of human and animal generation and movement. Imagined as a refined version of the blood, the animal spirits both animated the blood and supplied the animating spirit found in semen. Those same spirits then were responsible for locomotion, spurring an animal to move and act in order to find food and other creature comforts. Often invoked together, especially in discussions of horse and hawk training, but even in so human a discourse as Milton’s treatise on divorce, mettle and spirit describe a general temperament. For example, in Gervase Markham’s *Cauelarice* (1607), horse breeders are advised to “ride [...] foorth of company” horses that are “al spirite and mettle.”¹¹ The training of hawks requires a similar sensitivity to temperament, as Edmund Bert describes some hawks as having “much more spirit and mettle then the other; and will aske shorter or longer time in making.”¹² Lady Mary Wroth uses mettle

and spirit as synonyms when praising a friend for having “life, spirit, and mettle in her.”¹³ John Milton describes mettle and spirit as two elements of a complete person when arguing in favor of divorce, describing a forced marriage as something that “imbase[s] the mettle of a generous spirit, and sinks him to a low and vulgar pitch of endeavour in all his actions.”¹⁴ As both an active and passive generative material, mettle is also responsive to heat; because of this responsiveness, it is a spur to activity and movement.¹⁵ It thus recapitulates two functions ascribed to the animal spirits: generation and movement.

Through the lens of Norbert Elias’ discourse of civility, Paster sees the relationship between spirit and body as a paradoxical one that “celebrate[s] the possession of higher spirits as the birthright of finer natures but, at the same time, [...] discourage[s] impulsiveness and uncontrolled aggression and reward[s] consistency, staying power, predictability, and the control of aggression.”¹⁶ This relation appears paradoxical to Paster because “higher spirits” implies a lack of control whereas “consistency” implies a much more stable and earthy humoral makeup associated with lower born people. I argue that this relation only appears to be a paradox because Paster does not consider the metallic rules of interaction between spirit and substance—the mercury-sulphur theory of metallic generation in which a mercurial principle, or spirit, and a sulphurous principle, or earth, are the complementary elements making up a metal.

The puns between mettle and metal, therefore, are not merely homonymic; rather, mettle and metal share a similar sense of generation and change. Just as human mettle grows in the womb of a woman, so metals were thought to grow underground in the womb or bowels of the earth. The theories of metallic change originated in the alchemy

of the early middle ages.¹⁷ Far from being a mystical field of knowledge, early alchemy was based upon the empirical evidence of the behavior of actual metals found in Aristotle's *Meteorologia*, which stated that all minerals, stones, and metals found underground were formed by two types of exhalations that arose as a result of the sun heating the earth. Both exhalations—one wet and the other dry and smoky—combined to form hardened minerals. Under the influence of Islamic treatises by Jabir Ibn-Hayyan, early alchemists adopted the two types of exhalations to create the Sulphur-Mercury theory of metallic generation. This theory stated that all metals originated from the same two substances and that any differences among metals had to do with accidents of location and exposure rather than any intrinsic differences. This, in turn, suggested that the transmutation of metals from base to noble was possible given the optimal conditions of intense heat and aridity.

Similarly, as Floyd-Wilson has explored, one's mettle depended on the specific geohumoral conditions in which one was born. As the raw material out of which people were fashioned, mettle, like its mineral counterpart, metal, was, as Floyd-Wilson has demonstrated, malleable enough to be affected by climactic differences. In *Henry V*, the Constable of France invokes the influence of natal region on mettle when he expresses disbelief that the English possessed "mettle" in battle despite their native "foggy, raw, and dull" climate (3.4.15-16). Given their "dull" climate, the English are expected by the French to be, like Hamlet, "dull and muddy-mettled" and therefore ineffectual in battle. But, as Floyd-Wilson argues, the base matter of the English is, like iron, a substance that retains heat over long periods of time, thereby allowing for effectual action in exhausting battle. This moment, according to Floyd-Wilson, points to a civilizing discourse

articulating English exceptionalism in comparison to the Briton counterparts of the English: the Irish, the Scots, and the Welsh.¹⁸ However—and this is where I depart from Floyd-Wilson—the ability of the English to escape their regionally determined constitution was not necessarily predicated on the English civilizing discourse of raising the bar of temperance from the south to the north. Rather, the degree to which people were imagined to generate and retain heat signals a fundamental understanding of the self in terms of metals.

The Sulphur-Mercury theory referred not just to the physical referents of actual sulphur and mercury, but to two principles of metallic change essential to generation: coagulating and dissolving, which were enabled by applying heat to a metal. According to Lawrence Principe, the basic process of applying chemical sulphur to liquid mercury produced the coagulated substance cinnabar, and this process formed the basis of the analogical, alchemical principles of metallic change.¹⁹ This relationship between the principles of Sulphur and Mercury extended to an expansive network of analogical relationships, including that of human generation. Semen acted as the active, Sulphur principle that coagulated a passive Mercury of menstrual blood into a fetus.²⁰ The Sulphur-Mercury theory therefore spawned the notion that metals possessed vegetable properties of growth. Such theories further were substantiated by the existence of metallic specimens that mimicked the shapes found in nature, such as trees and plants.²¹

Early modern literary texts thematize the notion that mettle operated according to the metallic, and human, rules of generation. In *Measure for Measure*, Angelo threatens Isabella that he will execute her brother Claudio if she refuses to let him put his “metal,” or semen, in her “restrained moulds,” or womb (2.4.48). Here, “mettle” represents the

active generative substance of semen. In contrast, in *Richard II*, John of Gaunt is described as sharing “that bed, that womb, That mettle, that self mould” with King Richard (1.2.22-3). Here, “mettle” refers not to an active seminal fluid, but the passive matrix of the womb in which gestation occurs. In *Hamlet*, right before the Mousetrap play, the Queen requests Hamlet to sit with her, but Hamlet refuses and instead sits at the feet of Ophelia, saying “here’s metal more attractive” (3.2.110). Hamlet’s faint praise not only values Ophelia above his mother in absolute terms, but invokes the status of woman as both commodity and fertile receptacle for male mettle, perhaps even reminding his mother that as the newly-minted wife of his fratricide-committing uncle, her value and honor have fallen in his eyes.²² Siblings from the same parent can, in turn, share the same material or “self-same Mettle.” In *King Lear*, Regan, eager to get a piece of Lear’s estate, reminds her father that she is “made of that self-metal” (1.1.69) as Goneril and, therefore, deserves a proprietary share equal to hers. *Timon of Athens* takes the concept of self-same mettle to a universal level when, in a complaint to Nature, Timon wonders why humans, made of the “self-same mettle” as the earth, should be so thankless to the ground that produced them (4.3.179). As a kind of medium for genetic material, mettle relays the defining characteristic not only of an individual, but of one’s family, clan, or station. Mettle is therefore potentially a category of political as well as individual identification.

The volatility of mercury and the fixity of sulphur, in turn, describe two aspects of the self—a pneumatological side that interacts with the world through its own impetus and an earthy side that can be wrought by the efforts of another. In *Julius Caesar*, for instance, Cassius’ description of spirit as something to which neither “stony tower, nor walls of beaten brass,/Nor airless dungeon, nor strong links of iron,/Can be retentive”

(1.3.93-95) resonates with Bacon's portrait of spirit trapped in the "prison-house" of matter.²³ Cassius describes Brutus' mettle, in contrast, as something that "may be wrought,/From that it is dispos'd" (1.2.310-1) in spite of the "noble" (1.2.309) nature of its host. This distinction between spirit and mettle points to the tropic organization of metals in which the volatile component of metals is spirit-like mercury, whereas the fixed component is earth-like sulphur.

This symbiotic model of mettle and spirit resolves the paradox that Paster sees between noble mettle and spiritedness and is in fact pursued by Francis Bacon in his *Historie of the Dense and the Rare*, which attempts to erect a way of analyzing matter through its relative density. There, Bacon illustrates that the currency of metallic nobility is not spirit, a volatile substance, but materials that are uniformly dense like gold, which illustrates that "all pure metal is denser and heavier than impure."²⁴ Bacon chooses gold as "the standard to which other bodies should be referred" on the basis of its heavy weight and its uniform consistency, attributes that confirm for Bacon that gold has "nothing volatile about it."²⁵ This metallic model of material resolves the apparent paradox of possessing noble (and highly refined) mettle by birthright and yet remaining constant. In Bacon's *Novum Organum*, for instance, spirit is ineffectual without the matter that constrains it. Bacon explains that the "production of life" requires "both mildness in the heat and pliancy in the substance" so that the spirit may [...] be able to mould and model [it] like wax."²⁶ The substance of bodies, in turn, "wraps and clothes" the "invisible and intangible spirit" "as with a garment."²⁷ The noblest of all metals, gold, was commended not for its excess of spirit, which one would expect to signify the

ultimate in refined substances on its minimization of earthiness, but for its uniformity, its perfect mixture of both sulphur and mercury, earthy mettle and volatile spirit.

As in metals, which were thought to be composed of the constantly warring elements of mercury and sulphur, mettle was imagined to be affected by spirit and vice versa. In *Julius Caesar*, spirit describes that which spurs people to action, the medium of which is the mettle of the body. For instance, Brutus laments that he is not as “gameson” as Antony since he “lack[s] some part/Of that quick spirit” (1.2.28-9). Antony claims to channel his “quick spirit” into teaching Lepidus, whom he describes as a “barren-spirited fellow” (4.1.36) whose “corporal motion” is “govern’d by [Antony’s] spirit” (4.1.33), to fight. Barren-spiritedness implies a lack of spirit that only would occur if the corresponding mettle were not dense enough to trap the spirit. So a person who is barren-spirited would be composed of not a noble, dense mettle similar to gold, but a less dense base mettle like lead, which, on account of its less closely spaced particles, allows its own spirit to leave and others’ spirit to enter. An example of the mutability of base mettle is when Murellus, a tribune, describes the artisans anxiously awaiting Caesar’s arrival after his conquest as being so fickle that he challenges his companions to “see wh’er their basest metal be *not* moved” (1.1.61, emphasis mine), implying that they will shift according to whatever is in their best interest. The susceptibility of mettle to change is further seen in Brutus’ description of Casca as one who has grown “blunt” although he was “quick mettle when he went to school” (1.2.295-6). Here, Brutus suggests that “mettle” has some bearing on one’s demeanor, although Cassius clarifies that Casca assumes a “blunt” demeanor because it mitigates the sharpness of his observations.

Casca's strategy for appealing to others resonates with Brutus' disapproval of those "hollow men" who, "like horses hot at hand,/Make gallant show and promise of their mettle" (4.1.23-4). The "hollowness" of these men suggests that the particles of their mettle are not closely packed and therefore do not retain spirit. Their "gallant show and promise" of their capacity for action is disproven when they "sink in the trial" (4.1.27) of war and fail to "endure [its] bloody spur" (4.1.25). The qualities of both mettle and spirit therefore work in tandem to spur action in an individual. The mutual dependence of mettle and spirit, in which mettle is wrought by spirit and spirit is channeled by mettle, reveals the changes in the self to be akin to the workings of a craftsman.

The instrumentality of heat—a central feature of the metallic arts—in mobilizing spirit to shape and move mettle further implicates the spirit-mettle dyad in the discourse of artisanal knowledge. For instance, Macbeth implies that one's own traits can affect the gender of one's children when he famously tells his wife that her "undaunted Mettle should compose/Nothing but males" (1.7.73-4).²⁸ Whereas in *Measure for Measure*, "mettle" is defined as semen, here, Macbeth invokes the one-sex model of Galenic physiology to suggest that his wife's constitution is courageous and manly and therefore hot enough for her to father their children. In part two of *Henry IV*, Morton, a retainer of the seditious Earl of Northumberland, delivers a report eulogizing the Earl's son, the rebel leader Harry "Hotspur" Percy: "For from his metal was his party steeled,/Which once in him abated, all the rest/Turn'd on themselves, like dull and heavy lead" (1.1.116-18). Morton describes the exchange of mettle between Hotspur and his followers as a function of heat: he recounts that while Hotspur's "spirit lent a fire" to the "dullest peasant," his death "took fire and heat away" from the "best-tempered courage" (1.1.112-

15). The endpoints of Hotspur's spectrum of influence— the “dull” and the “tempered”— recall the range of material states available to a metal, which at its most unrefined is dull and leaden, and at its most refined, tempered and golden. Similarly, in *Alls Well that Ends Well*, the First Lord invokes the influence of an external source of heat when he wonders into “what metal this counterfeit lump of [ore] will be/melted” (3.6.37-8).²⁹

With excess heat, mettle could morph into a spastic, undirected, temperamental hotheadedness, as is the case with Fortinbras, whose mettle, albeit “hot and full,” is nonetheless “unimproved” (1.1.96). In *The History of Henry VIII*, the Duke of Norfolk likens anger to a “full hot Horse” that, left to its own devices, tires from its “selfe-mettle” (1.1.132-4). In *Measure for Measure*, Lucio advises Pompey to remain patiently in prison, or else his “mettle is the more” (3.1.325), referring not only to his rising temper, but to the inevitable increase in the number of iron shackles binding him should he refuse to comply. The association between animals and excessively heated mettle suggests that something more is at work in the carefully tempered degree at which human metal is most efficacious in both reproduction and action. What separates humans from animals is the engagement of the will, the very human faculty that transforms the matter of metals through the metallic arts.

The relation between purposeful or willed action and the practice of art can be observed in Hamlet's selection of a passage that describes action in terms of the union of one's will to one's matter, which, in turn, is made figural through the metallurgical work of Cyclops, Vulcan's workman. The “fiction” that Hamlet himself selects for the Player

to perform—a “passionate speech” (2.2.432) featuring “Aeneas’ [tale] to Dido” (2.2.446), “especially when he speaks of/Priam’s slaughter” (2.2.447-8)—prompts Hamlet to describe himself as a “dull and “muddy-mettled rascal.” By contrasting his “muddy mettle”—his excuse for not acting on the ghost’s information—with the player’s ability, “in a fiction” (2.2.552), to “force his soul so to his own conceit” (2.2.553) by acting on a stage, Hamlet implicates a certain quality of “mettle” with acting in the world. In contrast to the player, who interprets Hecuba’s passion and Aeneas’ narration of that passion by moving “his whole function” (2.2.556) or body to his “conceit” (2.2.557), Hamlet remains unmoved by his own “motive” for action. Moreover, Hamlet’s selection of a speech read more often than performed—as Hamlet recounts to the player that it was “never acted, or if it was, not above once” (2.2.434-5)—³⁰ itself suggests that Hamlet sets himself up for failure to act. Hamlet’s dilemma—his muddy-mettledness—resides in his inability even to think in terms of action. He phrases his delay in terms of “say[ing] nothing,” rather than *doing* nothing. Yet the content of the fiction he selects, Pyrrhus’ killing of Priam, proves significant for the way in which it couches the rousing of action in terms of metallurgical work—a type of action that underscores the mineral materiality of Hamlet and Fortinbras’ mettles.

Hamlet’s choice of a speech typically used to spawn more forms of expression presages his frustration that his muddy-mettle keeps him on the level of language rather than action. Yet, while the educational uses of the “passionate speech” preclude Hamlet’s emulation of the thematic content of “Priam’s slaughter” in the real world, the practice of copying and generating multiple forms of a theme would allow a schoolboy to generate abundant and artful ways of applying discursive forms to his “conceit” (2.2.557), as the

player does with his “soul” and “function.” In light of the educational uses of this passage from the *Aeneid*, Hamlet’s muddy-mettle, while unfit for action, is suited to composing poetry, thereby suggesting that the description of the self in terms of mettle is implicated in the early modern understandings of imaginative writing.

Although no explicit mention is made of Pyrrhus’ mettle within the speech that Hamlet requests the visiting player to perform, Pyrrhus’ renewal of his intention to act depends upon a metallurgical “conceit” of renewing strength with heat generated on a forge. Here, a figurative “conceit” of metals drives the actual mechanism of mettle thought to spur action. The metallurgical skill of Cyclops, assistant to Vulcan, the Roman god of the forge, therefore circumscribes Pyrrhus’ violent action against Priam. Hamlet starts Aeneas’ tale to Dido at the point when “rugged Pyrrhus” (2.2.452) is introduced. Like Hamlet, Pyrrhus experiences a “pause” before killing Priam. The very figure of “hellish Pyrrhus” (2.2.463), “roasted in wrath and fire” (2.2.461), in fact, seems to emerge from a furnace. When Pyrrhus’ “vengeance” (2.2.488) is “roused” (2.2.488) after his “pause” (2.2.487), it sets him “new a-work” (2.2.488) toward his goal. He completes his goal with as much intensity as “Cyclops’ hammer fall[s]/On Mars’s armor” (2.2.490). Pyrrhus renews his ability to act, to unite his “will” to his “matter,” just as Cyclops unites his “hammer” with “Mars’s armor.”

The metallurgical content of this copied passage from the *Aeneid* reinforces Hamlet’s inability to act by providing him with yet another variation on the theme of failing to apply one’s soul to one’s conceit. Pyrrhus’ “pause” (2.2.487), which renders him “as a neutral to his will and matter” (2.2.481), is instructive in explaining Hamlet’s “dull” “mettle” (2.2.567). The parallels between Hamlet’s hesitation to avenge his

father's murder and Pyrrhus' "pause" in avenging the rape of Helen further suggest that "muddy mettle" indicates someone who is "neutral" or cannot ignite the link between will and matter—a connection necessary for even the most basic of physical movement in animals, according to Aristotle's *De Anima*.³¹ Hamlet's "muddy mettle" therefore suggests a constitutional slowness in moving oneself—emotionally and physically—toward a purposeful end. Extrapolating from the parallel between Hamlet and Pyrrhus, I argue that "mettle" can be described as the tendency to unite one's will with one's matter—a tendency that overlaps with the definition of the metallic arts as willed actions on the wielding, inanimate matter of metals.

That action, the link between will and matter (be it one's own matter or the matter of the earth), is mediated through the metallic arts can be attributed to a pervasive early modern intellectual phenomenon. The early modern educational corpus of Aristotelian texts prove important in the larger culture for explaining the ways in which artisanal making such as that involved in the metallic arts aptly describes deliberative action. Aristotle's *Nicomachean Ethics* lays out a much more extensive account of the deliberatively-directed actions of humans. The *Ethics* organizes knowledge into three parts: the theoretical, the practical and the productive.³² Purposeful action, or *praxis*, comprises practical knowledge and involves the exercise of judgement or *phronesis*. *Phronesis*, in turn, represents the ability to judge the facts of a particular situation in light of a guiding principle. Productive knowledge, or *poiesis*, is also a kind of action that, rather than serve as an end in itself like *praxis*, has its end in its produced objects.³³ Art or *techne* comprises the realm of *poiesis*. Whereas *praxis* involves action oriented toward politics and ethics, *poiesis* comprises action oriented toward matter. All three spheres of

knowledge were separated from one another, especially the realms of *praxis* and *poiesis*.³⁴ Likewise *phronesis* and *techne* were sharply divided.³⁵

But, as scholars have pointed out, Aristotle frequently described *praxis* in terms of *poiesis*, for instance citing cobblers as exemplars of *phronesis*.³⁶ Henry Turner suggests that similar to *praxis*, *poiesis* and its attendant art, *techne*, involved phronetic thinking because an artist had to apply the rules of his or her art to the particular “facts” of the material with which he or she worked. Turner describes the similarities between *phronesis* and *techne* as evidence of “quasi-empirical” thought because both required making generalizations based on sense data. He further suggests that the interplay between practical and productive knowledge within the Aristotelian corpus encouraged sixteenth-century students to make connections across both domains, a phenomenon conterminous with the rise of the mathematical sciences, which attempted to quantify and rationalize the tacit operations of technical fields such as metallurgy, mining, shipbuilding, and carpentry to improve nature.³⁷ To yoke this artisanal disposition of making and creating with action is therefore symptomatic of this burgeoning early modern phenomenon of authorizing one’s actions in terms of the technical knowledge of the material world—a phenomenon that eventually blossoms into the experimental science of the seventeenth century. I explore the authorization of actions in terms of technology in chapter two, where I describe the ways in which promoters of English New World mining projects invoke the assaying of New World ores to justify their failed actions in the Americas; in so doing, these promoters elaborate an emergent model of English metallic skill that resonates with the Aristotelian cross-pollination between action and making for its authority.

Pyrrhus' purposeful action, in being described as "work," draws upon the Aristotelian connections between acting and making. Pyrrhus can act because he phronestically connects the sense data of the "hideous crash" (2.2.476)—a tactic that "senseless Ilium" (2.2.474) uses to register the fall of its leader Priam and to distract Pyrrhus by "tak[ing] prisoner [his] ear" (2.2.477)—with his own sense of revenge. Hamlet, on the other hand, lacks the sense data necessary to act. Hesitant to trust a "spirit" (2.2.598) that "may be a [dev'il]" (2.2.599) or the product of his own "melancholy" (2.2.601), Hamlet requires "grounds/more relative" (2.2.604) to "catch the conscience of the King" (2.2.605). Hamlet's muddy mettle, his apparent constitutional inability to act, therefore can be read in terms of his lack of the "stuff" and matter of *phronesis*.

What is at stake in describing the acting self in terms of a phronestically defined technology? On the one hand, associating the acting self with technology reverses the critical commonplace of Norbert Elias, who argues that the technicizing of the self is an effect of modernity and a form of affect-control.³⁸ According to Elias, the civilizing process depends on the suppression of bodily functions such as defecating and urinating; the modern subject comes into being through an increase in scientific and technological knowledge, but at the cost of ordering and rationalizing the processes of the body. I argue, on the other hand, that technology does not necessarily represent a repression of bodily processes; instead, the invocation of mettle-metal implied by the technical references to the refining or tempering of the self hearkens back to a primal part of the self shared with even animals, as in the examples of horses and hawks possessing specific

types of mettle. Rather than *control* affect, technologies of mettle *produce* affect that has the power of mobilizing an individual toward action.

The theories of the increasingly technicized self rely on a modern notion of technology, which implies an exploitative relationship between the self and the earth. Such views of a self alienated from the earth can be found in Martin Heidegger's readings of technology as a testament to modernity.³⁹ Following laments such as Heidegger's over the postlapsarian state brought about by modernity, Carolyn Merchant argues in *The Death of Nature* that criticisms of the ecologically harmful practices of mining had started as early as the early modern period.⁴⁰ The key difference between early modern and modern readings of technology lies in the notion of nature in the early modern period.⁴¹ Nature, in Aristotelian thought, referred not to a pristine preserve, as Heidegger and Merchant describe it, but to the habitual way things were. Technology, or *techne*, in turn, referred to the human effort to engage with nature, not to exploit it, but to emulate, improve, or merely reproduce it. Jean-Luc Nancy, whose deconstructionist reading of Heidegger resonates with the interactive early modern understanding of *techne*, puts it best when he writes in his *Sense of the World* that "an ecology properly understood can be nothing other than a technology."⁴²

In keeping with the notion of the intervention into nature as a productive action, Michael Schoenfeldt has described the processes of eating, digestion, and bloodletting as moments not of repression, but of a productive self-fashioning dependent not on relations of power, but on individual action.⁴³ Following Schoenfeldt, my dissertation explores how the technicizing of the substance of the self, or mettle, through metalworking enables a legible model of the self, a model that is articulated in diverse discursive

productions, from stageplays to travel correspondence to political tracts. The example of Pyrrhus' action being spurred by work, for instance, mobilizes the player to express emotion and prompts Hamlet to articulate his own grief about his father and his helplessness in doing anything about it.⁴⁴ The mobilization of poetic action that Pyrrhus effects within the realm of literature translated into a broader English cultural of metals as well, which I explore in chapter one. One of the defining characteristics of that culture involves acting by proxy, an instance of individuals undertaking the humanistic activity of translating the work of miners in the service of the state. Because the Crown had a vested stake in mining prospects under the auspices of the Society of the Mines Royal, and peers to the Crown were motivated to mine their lands to obtain monopolies for the processing of a specific type of metal, the metallic arts were political because they required someone to translate the "doings" of a skilled craftsman or day laborer into terms intelligible to people in power. In chapter two, I describe the case of Martin Frobisher's second and third voyages to the Northwest Passage, which were funded largely on the hope stimulated by a piece of gold-rich ore found on the first voyage. For those voyages, the administrator of the enterprise, Michael Lok, was responsible for communicating to the Queen, Privy Council, and numerous noble investors, including the Sidney family, and others the progress and actions of the navigational and mining practitioners under his purview.⁴⁵

The centrality of artistic practice to a description of how quickly or slowly the English could be moved toward action therefore confirms Jean Bodin's ascription of the manual arts to phlegmatic, moist Northerners. This is a point that Floyd-Wilson and Ian MacInnes mobilize in the service of their arguments regarding the relative barbaric nature

of English mettle vis-à-vis civilized Mediterranean mettle.⁴⁶ I argue, in contrast, that the explanatory force that mettle draws from the metallic arts—a manual art that in the recent past had been elevated to the status of humanistic knowledge through publication in treatises and which included the age-old techniques of alchemy—rendered mettle a faculty that crossed boundaries of social status and regional affiliation. In what follows, I argue that the literal fashioning of the self through artisanal technologies was a possibility relevant to early modern middle-class literary and cultural stylists, who, as other scholars have shown, were keen to legitimize their inherited and earned guild associations as equivalent to the status of gentlemen.

That the early modern literary heritage of metals tends to align mineral manifestations of earthly matter with the baser aspects of our fleshly inheritance would seem to affirm the anti-technology theorists. But, as Stephen Greenblatt explains, the self fashions itself in opposition to an alien other.⁴⁷ I argue that the literary heritage of metals acts as the “other” against which early modern selves defined their action. Metals in the early modern period usually were associated with immorality and sin, especially within the Ovidian narrative of the shift from the Golden Age to the Iron Age, which vilified the corruption brought on by mining, a practice that taught humans to covet gold and forge weapons for warfare.⁴⁸ Metalworking often was cited as the demonic other of a more godly agrarianism, as is the case in promotional texts of the New World such as Thomas Harriot’s *A Briefe and True Report of the New Found Land of Virginia* (1590), which, eager to divert the attention of investors away from the uncertain prospects in mining, describes the agrarian treasures of Virginia as “vegetable gold.” The Black Legend of Spanish cruelty against indigenous New World inhabitants, especially in mines,

contributed to this anti-mining sentiment.⁴⁹ Alternatively, mines are the sites of perverse order in the two major early modern epics: in Book Two of Edmund Spenser's *The Faerie Queene*, Guyon, the Knight of Temperance, descends into Mammon's cave, which features an alchemical laboratory mirrored, in the next canto, as a kitchen upholding bodily order in Alma's Castle of Health; in Milton's *Paradise Lost*, the empire that the fallen angels build in Hell replicates the stature of Heaven with buildings made of gold, the very material that lined the pavements of Heaven. These negative connotations of metals, as Anthony Miller recently has argued, do not necessarily limit the rhetorical scope of metals.⁵⁰ As an alien other against which the English defined themselves, metals provided an opportunity for the English to visualize externally the production of the self. Taking issue with Greenblatt, whose invocation of the word "fashion" in his seminal study on the creation of the Renaissance self is too quick to move to the metaphorical fashioning of self through behaviors, gestures and texts, I consider the literal links between fashioning and the self found in the metallic arts. My dissertation, therefore, pushes on Greenblatt's invocation of Clifford Geertz's contention that human beings, and not just art, are "cultural artifacts."⁵¹

In the chapters that follow, I consider technical accounts and literary representations of mettle, tracing the ways in which the self relies on technologies of metal to express purposeful and, at times, ethical actions. Chronologically, the dissertation moves from the 1570s to the first decade of the seventeenth century and then into the later half of the seventeenth century. From George Best's *True Account* of Martin Frobisher's voyages (1578) to John Pettus' *Fleta Minor* (1683), myriad English texts

illustrate my argument that technologies of mettle allowed practitioners and writers to define human purposiveness in terms of the metallic arts—a phenomenon in keeping with the rise of experimental knowledge. While a direct reference to “mettle” appears with regularity only in the stage-plays I discuss, metals and their cognate technologies (such as assays, refining, and tempering) describe people engaged in various states of purposeful action.

The technologies of metal that figure in my dissertation include: mining, smelting, fining, refining, assaying, and tempering; they also imply the arts involved in alchemy and chymistry. Perhaps the technique most demanding on a metalworker was mining, which involved the excavation of ores from deep within the earth and from superficial surfaces. Rarely did English miners find metals in their pure or native state. In order to justify the expenditure of mining on a large scale, the assay proved useful because it involved a small-scale test of ore.⁵² The fire-assay was the most definitive test of an ore’s content, although in a pinch, a goldsmith roughly could gather an ore’s metallic content by matching its mark on a touchstone with that of a touch-needle of a predetermined quantity of the metal in question. Since touching gave only rough estimates, the fire-assay was deemed more useful to justifying large mining projects. Assaying involved the melting of an unknown ore with a leaden compound in a crucible. This molten amalgam then would be transferred to a cupel, a porous receptacle usually made of bone ash. After being placed in a fining furnace, the cupel would heat up, and the waste material therein would be absorbed into the walls of the cupel, leaving behind a small “button” of lead, gold, and silver. This “button” then could be further purified by being doused with nitric

acid or parting water, which would react with any remaining waste materials, leaving behind a purified “bead” of metal.

Once the small-scale analysis of the assay provided satisfactory results, the large-scale work of mining, fining (or heating), and refining metals could begin. The process of fining the metal repeatedly could be conducted (hence the word “re”-fining) until the desired amount of metal was extracted from the ore. Refining, the repeated heating of metallic compounds, was conducted in order to create various mixtures of metals and ores for industrial purposes. To further strengthen metals, therefore, metalworkers mixed, or tempered, the metals with base materials and finally founded them into wares. The entire process of processing metals— from excavating to assaying to refining to tempering—demonstrates that technologies of metal offer a developed vocabulary for describing a metalworker’s interactions with a metal. The four chapters of my dissertation argue that the language and techniques of the metallic arts provide writers with a means to articulate various modes of purposeful action, and to thereby show that mettle of the English self mines meaning from the base metals that populate the veins of the English body politic.

Chapter one, “An English Culture of Metals,” describes the ways in which the literary deployment of the metallic arts in the form of alchemically themed satire approximated actual aspects of the English culture of metals. Taking Ben Jonson’s play *The Alchemist* as my literary point of reference, I describe the geographic and social expansiveness of a culture that extended from the household and its metal fire-tending and cooking tools, to the metalworking neighborhoods of London and its environs, to the metal-rich provinces in which royal administrators and courtiers leased out their land to

middlemen who orchestrated mining projects. I then compare the often satirized processes of gold-making or *chrysopoetics* to the actual processes described in the mining, metallurgical, alchemical, and chymical literature, emphasizing the overlap between the limited literary scope of references to metals and their actual deployment in industry. In particular, I demonstrate the ways in which the processes of the metallic arts derive their authority from the experience and noble character of the practitioner who conducts them, a relation between metals and selfhood that is inverse to that described in literary satire, which describes alchemists as inherently deceptive. This chapter sets the historical stage for the following chapters, which chart the specific ways in which metallic practices were deployed in defining early modern English selfhood.

Chapter two, “Assaying English Metallic Skill in the New World,” reads England’s repeated encounter with base metals in the New World as the backdrop for the emergence of a model of selfhood derived from metallic skill. George Best’s accounts of Martin Frobisher’s voyages to the Northwest Passage, letters by Michael Lok to the Privy Council detailing the voyages, Walter Raleigh’s *Discoverie of Guiana*, and a variety of travel narratives written by John Smith all describe various ways in which New World base metals required the English to elaborate their skill in assaying and refining ores—a talent that proves to test their own characters in the process.

Chapter three, “The ‘Tyrant Custom’ of War: The Construction of Military Mettle through the Metallic Arts in Shakespeare’s Plays,” comes to terms with the military connotations of mettle, which draw heavily upon the metallic sense of “mettle” to denote a hard resilience to the tough conditions of war. In contrast to readings that assume the link between military courage, or mettle, and metal in terms of a Platonic analogy

between flesh and earth, I consider the technological interface necessary to implement mettle in war: the making of weapons. I read the shift in early modern military practice toward gunpowder and cannons—a practice that implicates the metallic arts into constructions of military courage—as providing a vibrant metaphor for purposeful action both on the battlefield and on stage.

Chapter four, “Teaching Ethical Action through the “Corporal Forms” of Metals in Milton’s Early Prose and *Paradise Lost*,” argues that Milton draws upon the discourse of metals in his early prose and *Paradise Lost* to articulate an ethics of reading that encourages readers to understand good through evil. His positive uses of the imagery of mining and metals depart from the commonplace Ovidian reading of metals as the products of an impious, fallen, Iron Age. Honing in on the notion of metallic mixture that informs metallurgical understandings of temperance, Milton grapples in his poetry, I argue, with the postlapsarian necessity of relying on “corporal forms” (the material metaphors that Raphael uses to explain the universe to Adam) to craft souls into perfection.

The above chapters all show the ways in which the literary and non-literary uses of metallic technology figure an emergent sense of English selfhood. The importance of showing the use of this technology is to demonstrate that the faculty of mettle, which was thought to spur the self toward action, depended on its homonymic and substantive similarities to metal for its legibility. The use of technology to describe purposeful action, in turn, highlights the growing role of an often tacit, innate, and experiential knowledge of making, or *techne*, in describing judgement, or *phronesis*, typically associated with

reason rather than with an inarticulable experience. Hamlet, who, despite recognizing the required formula for action—a mettle unlike his “dull” and “muddy” one that spurs the self to unite its will to its matter—delays his action until the end of the play. Hamlet’s inability to be spurred by the metallurgical “conceit” that moves Pyrrhus to kill Priam has been cited as one of the moments during which Hamlet articulates a sense of his own affective interiority. I argue, instead, that unlike Fortinbras, who deploys his “hot and full” mettle to assume the filial duty of avenging his father’s honor, Hamlet creates an interior sense of self at the expense of a politically engaged, outwardly-directed self. If Renaissance self-fashioning occurs by means of an alien other, then Hamlet and Fortinbras, along with many other early modern characters and subjects, are fashioned through a different form of otherness than is often assumed: the geological material of metals.

¹ This and all subsequent references to William Shakespeare’s plays are in *The Riverside Shakespeare*, ed. G. Blakemore Evans (New York: Houghton Mifflin, 1997). All citations to Shakespeare’s plays will be cited parenthetically in the body text.

² Mary Floyd-Wilson, “English Mettle” in *Reading the Early Modern English Passions*, 130-46, eds. Gail Kern Paster, Katherine Rowe, and Mary Floyd-Wilson (Philadelphia: University of Pennsylvania Press, 2004), 132.

³ Paster, “The Body and Its Passions,” *Shakespeare Studies* 29 (2001): 44, quoted in *ibid.*

⁴ Floyd-Wilson, 132.

⁵ Paster “Nervous Tension,” 109, quoted in *ibid.*, 324n8. For Paster’s reading of the social differences signified by the spirits, see Paster, 120, quoted in Floyd-Wilson, 325n 33.

⁶ Recent studies include Michael Schoenfeldt, *Bodies and Selves in Early Modern England* (New York: Cambridge University Press, 1999), Paster, *The Body Embarrassed* (Ithaca, NY: Cornell University Press, 1993), *Reading the Early Modern Passions*, and Jonathan Gil Harris, *Sick Economies: Drama, Mercantilism, and Disease in Shakespeare’s England* (Philadelphia, PA: University of Pennsylvania Press, 2004).

⁷ For a “geohumoral” account of the effects of climate on prevailing notions of regional characteristics and race, see Mary Floyd-Wilson, *English Ethnicity and Race in Early Modern Drama* (New York: Cambridge University Press, 2003).

⁸ See Richard Strier and Carla Mazzio, “Two Responses to ‘Shakespeare and Embodiment: An E-Conversation,’” *Literature Compass* 3.1 (2005): 15-31. For an

overview of an earlier call against an equally hegemonic description of early modern embodiment— Thomas Laqueur’s “one-sex model” of the body—see Belinda Johnston, “Renaissance Body Matters: Judith Butler and the Sex that is One,” *International Journal of Sexuality and Gender Studies* 6.12 (2001): 77-94.

⁹ Ibid.

¹⁰ Molly Mahood describes “mettle” as an example of a “portmanteau” word—a word that simultaneously means two things. See her *Shakespeare’s Wordplay* (London: Methuen, 1957), 16.

¹¹ Gervase Markham, *Cauelarice, or The English Horseman* (London, 1607), ch. 3.

¹² Edmund Bert, *An Approved Treatise of Hawkes and Hawking* (London, 1619), 57.

¹³ Lady Mary Wroth, *The Countesse of Montgomeries Urania* (London, 1629), 485.

¹⁴ John Milton, *The Doctrine and Discipline of Divorce* (London, 1643), 41.

¹⁵ On the vital and animal spirits, see Nancy Siraisi, *The Clock and the Mirror* (Princeton, NJ: Princeton University Press, 1997), 108. For a treatment of the spirits in early modern literature, see Paster, *The Body Embarrassed*, 71-3, 87, 103 and Schoenfeldt, 83, 99-100, 116-7, 146-7.

¹⁶ Paster, *Body Embarrassed*, 120.

¹⁷ The following account of the Aristotelian origins of alchemy and the various permutations of alchemy draws heavily from Lawrence Principe, *The Aspiring Adept: Robert Boyle and His Alchemical Quest* (Princeton, NJ: Princeton University Press, 1998), 37-42.

¹⁸ On the climactic effects on a mettle understood to be a marker of male, martial courage, see Floyd-Wilson, “English Mettle,” 132.

¹⁹ Principe, *Aspiring*, 39.

²⁰ Ibid.

²¹ Carolyn Merchant, *The Death of Nature* (San Francisco: Harper San Francisco, 1989), 25-8

²² “Metal” is used only in Q5 (1637) whereas in Q1-4 and F1, “mettle” is used. This editorial decision suggests that the substance of the women in the play is stabilized to a comparison with a literal referent of value, whereas before, the humoral meaning was still a possibility.

²³ Francis Bacon, *Novum Organum* in *The Works of Francis Bacon*, edited by J. Spedding, R.L. Ellis, and D.D. Heath, vol. 5 (London: Longman, 1857), 194.

²⁴ Francis Bacon, *The Historie of the Dense and the Rare in Works*, 381-2.

²⁵ Ibid., 342.

²⁶ Ibid., *Novum Organum*, 196.

²⁷ Ibid., 194.

²⁸ For an exploration of this scene’s double pun on male/mail and mettle/metal, see Janet Adelman, *Suffocating Mothers: Fantasies of Maternal Origin in Shakespeare’s Plays, Hamlet to The Tempest* (New York: Routledge, 1991), 139.

²⁹ F1 uses “mettle” and F4 uses “metal.”

³⁰ See Margreta De Grazia “Hamlet’s Thoughts and Antics,” in *Early Modern Culture: An Electronic Seminar*, 2001 <<http://www.eserver.org/emc/1-2/degrazia.html>> (17 February 2007).

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- ³¹ See Christopher Shields, "Aristotle's Psychology," in *The Stanford Encyclopedia of Philosophy*, edited by Edward N. Zalta, Winter 2005
<<http://plato.stanford.edu/archives/win2005/entries/aristotle-psychology>> (25 July 2006). The physiology described therein, in turn, underscores the corresponding ethical theories of action espoused in the *Nicomachean Ethics* and the *Politics*.
- ³² Henry S. Turner, *The English Renaissance Stage: Geometry, Poetics, and the Practical Spatial Arts 1580-1630* (New York: Oxford University Press, 2006), 48.
- ³³ Joseph Dunne, "An Intricate Fabric: Understanding the Rationality of Practice," *Pedagogy, Culture and Society* 13.2 (2005):367-89, 375.
- ³⁴ *Ibid.*, 368; Turner, 48.
- ³⁵ Dunne, 375.
- ³⁶ Turner, 48. On the use of *poiesis* to illustrate *praxis* as being a sign of the rise of technical rationality, see Dunne, 368. For an account of the *praxis-poiesis* interaction in terms of sixteenth century artisans' political ties with patrons who then converted their mechanical know-how into authoritative technical knowledge, see Pamela Long, "Power, Patronage, and the Authorship of *Ars*: From Mechanical Know-How to Mechanical Knowledge in the Last Scribal Age," *Isis* 88.1 (1997):1-41; also see Long, *Openness, Secrecy and Authorship* (Baltimore, MD: Johns Hopkins University Press, 2001).
- ³⁷ See Peter Dear, *Discipline and Experience* (Chicago, University of Chicago Press, 1995); Eric H. Ash, *Power, Knowledge, and Expertise in Elizabethan England* (Baltimore, MD: Johns Hopkins University Press, 2004); and Long for an account of this gradual process of authorizing the technical sciences through their association with mathematics and method. Turner considers the literary implications of the rise of the mathematically-inclined "spatial arts."
- ³⁸ Norbert Elias, *The Civilizing Process* (Malden, MA: Blackwell, 2000).
- ³⁹ Matthew Jordan, *Milton and Modernity* (New York: Palgrave, 2001).
- ⁴⁰ See Merchant.
- ⁴¹ See Lorraine Daston, "The Nature of Nature in Early Modern Europe," *Configurations* 6.2 (1998): 149-72; and eds. Lorraine Daston and Fernando Vidal, *The Moral Authority of Nature* (Chicago: University of Chicago Press, 2003).
- ⁴² Jean-Luc Nancy, *The Sense of the World* (Minneapolis, MN: University of Minnesota Press, 1998), 41.
- ⁴³ Schoenfeldt, 9-12.
- ⁴⁴ Lynn Enterline describes the player as "the negative example against which Hamlet lays claim to what he would call his own feelings" (*The Rhetoric of the Body from Ovid to Shakespeare* [New York: Cambridge University Press, 2000], 166).
- ⁴⁵ Robert Baldwin, "Speculative Ambitions and the Reputations of Frobisher's Metallurgists" in *Meta Incognita: A Discourse of Discovery*, ed., Thomas H.B. Symons (Hull, QE: Canadian Museum of Civilization, 1999), 413.
- ⁴⁶ Floyd-Wilson, 138; Ian MacInnes, "Mastiffs and Spaniels: Gender and Nation in the English Dog," *Textual Practice* 17.1 (2003): 21-40, 28.
- ⁴⁷ Stephen Greenblatt *Renaissance Self-Fashioning* (Chicago: University of Chicago Press, 1983).
- ⁴⁸ See Jonathan Bate, *Shakespeare and Ovid* (Oxford: Oxford University Press, 1993) and A.B. Taylor, *Shakespeare's Ovid* (New York: Cambridge University Press, 2000).

⁴⁹ On the uses of Las Casas' text in Elizabethan England, see Andrew Hadfield, *Literature, Travel, and Colonial Writing in the English Renaissance 1545-1625* (Oxford: Clarendon Press, 1998), 91-2. On the misappropriation of that text in the service of the anti-Catholic sentiment of the Black Legend, see William S. Maltby, *The Black Legend in England: The Development of Anti-Spanish Sentiment, 1558-1660* (Durham, N.C.: Duke University Press, 1971), 15.

⁵⁰ Anthony Miller, "Ben Jonson and "the proper passion of Metalls," *Parergon* 23.2 (2006): 71.

⁵¹ Greenblatt, 3.

⁵² On the financial importance of the assay see Vannuccio Biringuccio, *Pyrotechnia* (New York: Dover, 1990): "In order to make sure what kind of metal the ore contains, what its quantity, what its companions, and what its purity or impurity, it is necessary before any expenditure is made to assay it one or more times" (16).

Chapter One: An English Culture of Metals

SIR MAMMON EPICURE:
This night, I'll change
All that is metal, in my house, to gold:
And, early in the morning, will I send
To all the plumbers and the pewterers,
And buy their tin and lead up, and to Lothbury
For all the copper.
SURLY:
What, and turn that too?
SIR MAMMON EPICURE:
Yes, and I'll purchase Devonshire and Cornwall,
And make them perfect Indies!
(The Alchemist, 2.1.29-36)¹

This exchange between the knight Sir Mammon Epicure and his skeptical companion Surly in Ben Jonson's 1610 play, *The Alchemist*, provides an illustrative example of the interplay between the alchemical and metallurgical discourses in the early modern English culture of metals. Although *The Alchemist*, on the one hand, satirizes Mammon's susceptibility to what Subtle, the alchemist in the play, describes as the "dream" of an "age of gold," on the other hand, it reveals the extent to which alchemy depended on the practical metal trades in early modern England. While others have read the alchemical content in the play as an allegory for theatrical practice and social ambition,² in this chapter I employ Jonson's play to frame my argument that there existed an early modern English "culture of metals." In particular, the play alludes to three significant aspects of this culture of metals, of which alchemy comprised a part: 1) the English metallic industry spanned the realms of London household and provincial

country manor, thus demonstrating the geographic pervasiveness of metallurgic industry and thought in early modern England; 2) the work of metals was conducted by proxy; those who owned mineral-bearing lands did not necessarily know how to mine them and, therefore, hired those who did know—thus reminding us of the relevance of skilled knowledge in metallurgy, a productive dimension of English selfhood that provides a counterpoint to the exploitative, interventionist understanding of technology; 3) the methods of searching out, mining, smelting, and refining ore into metal comprised a way of knowing that both overlapped with the satirical treatment of deceptive alchemical practice and rearticulated that satire to reveal a metallic way of knowing based not on fraud but on honest dealing and actual hard-won skill. Skill, in pointing to a productive sense of self, transforms the metalworking of the literary imagination from a futile endeavor to a mode of self-fashioning. In projecting his dream of an age free of poverty or sickness on all the base metals of England, Mammon unwittingly reveals that the hopes of attaining the social panacea of alchemical gold depends on a very practical English culture of metals. This dual attitude of appreciation for contemporary metalworking and skepticism about it illustrates that the English culture of metals exceeds the bounds of its literary imaginings.

Sir Mammon Epicure's boast to "purchase Devonshire and Cornwall,/And make them perfect Indies!" both belies and reveals a culture of metals within England that self-consciously defines itself in terms of the riches of precious gold and silver from the West Indies. Mammon's description of the Indies as "perfect" stems from its stores of gold, which in alchemical discourse was understood as the perfect metal on account of its

purity, ductility, and purported medicinal virtues. The synecdochic use of the Indies to refer to the high probability that a region would yield gold persisted even into the seventeenth century, when Dud Dudley, one of King James' many patentees to attempt to smelt iron with sea-coal, described Scotland as "our North Indies abounding in Mines and Minerals" on account of its supposed abundance of gold.³ Mammon furthers the synecdoche between riches and the New World when he describes Lovewit's house as the "Nove Orbe" and "rich Peru" (2.2.2) when, in fact, Lovewit's house and the actual playhouse that represents his house are located in the district of Blackfriars, an area of London known for its goldsmiths. The play references the metal-working community of Blackfriars in an offhand way in Act Five, when Neighbor Three, a smith, runs to fetch his tools in order to unlock Lovewit's door for him.⁴ But, in practice, goldsmiths played roles more significant than the mere prying open of locks. In addition to metalworking, they performed a number of monetary duties such as banking and assaying the kingdom's coinage, as in the Trial of the Pyx, the Royal Mint's official testing of coinage.⁵ In Martin Frobisher's voyages to the Northwest Passage, as I will describe in detail in chapter two, several goldsmiths helped to test ore brought back from Baffin Island even though their prior assaying experience was limited, most probably, to testing gold wares.⁶ In light of the important role that goldsmiths played in the production of coinage, Mammon's description of Lovewit's house and its environs in terms of the riches of the New World is less hyperbolic than stereotypes about alchemy might lead us to believe. In layering references to the London metal-working trades with references to the near-mythical scope of Spanish New World riches, Mammon draws from and illustrates the overlap between practical metallurgy and alchemy.⁷

Mammon's plans to raid and alchemically transmute his household inventory of metal goods, the lead and pewter of London, and the copper mines of Devon and Cornwall once Subtle delivers to him the philosopher's stone make painfully obvious England's lack of precious metals. Gold and silver were known to exist not in England, but in hotter climates like "Scythia and in those regions called oriental, perhaps because the sun seems to shine forth with greatest vigor in those places."⁸ The only claims to precious metals that England could boast of were the ancient remains of silver-bearing, or argentiferous, lead waste, or slag, which could be found in areas such as Derbyshire, Newcastle, and Hull.

But England's lack of silver and gold production did not deter its populace from the mining of other metals.⁹ England, in fact, had a rich and prosperous history of mining and metallurgy, starting with the ancient tin, copper, and lead industries of Northumberland, Derby, parts of Wales, the Mendips, and Cornwall.¹⁰ These historic tin and copper mines continued to be productive even when the English iron and lead industries flourished economically; iron was used to forge armaments and farm tools, and lead was exported to the German states as a smelting agent for a silver extraction process.¹¹ During the sixteenth and seventeenth centuries, for instance, England had a near monopoly on tin in Europe.¹² The copper mines of Devon and Cornwall, although difficult and expensive to work, nonetheless contributed to the brass industry. Copper, found additionally in Cumberland and Wales, and the zinc-based compound calamine, mined in the Mendips, both were used to produce brass armaments.¹³ But, the brass industry could not survive on this limited supply of zinc ore, so the search for a plentiful source of pure metallic zinc motivated, in part, the exploration and settlement of

Virginia.¹⁴ The extension of the English metal manufacturing industry to England's North American colonies provides a basis of sorts for the connections that Mammon draws between England and the New World, albeit in a very practical, rather than utopian, guise.

Mammon's plans to go to Devonshire and Cornwall and convert its copper into gold reflect the rural nature of English mining. The mining and smelting of ores was primarily a rural enterprise for the simple reason that mines were located on the manors of large landowners.¹⁵ Only those landowners whose estates were near either the coast or a river and a forest full of the timber necessary to fuel high-temperature furnaces could afford even to consider entering the extractive industries.¹⁶ For instance, the Sidneys' estate in the iron-wielding Sussex Weald was well situated because it was near the forests and rivers integral to the fueling and operation of furnaces, drains, bellows, waterwheels, and the finery forge.¹⁷ Because of difficulties in transporting raw material to manufacturing centers such as London, towns often grew to accommodate nearby rural mining industries. For example, the Midland industrial town of Birmingham relied on local iron ore, coal and timber for its timber industry.¹⁸ Similarly, during the reign of James I, the towns of Westmoreland and Cumberland grew in order to accommodate the local mining industries and to provide ports for trade.¹⁹ Still, despite the flourishing of cities around mining sites, an internal trade of tin, lead, and iron existed between provincial mines and London, where the bulk of workshops dedicated to producing finished metal goods resided.²⁰ Finished goods such as iron tools for farmwork and brass and pewter utensils for tending household cooking fires, along with continental imports, were then redistributed to the provinces.²¹ Mammon's intended trajectory from his

household to the workshop to the provinces traces in reverse the very track whereby English metals and metalwares circulated in England.

Mammon's superimposition of the vastness of New World riches onto the local metal trades of Blackfriars and greater London speaks to the metal-yielding potential of English mines in an unexpected way. Rather than propose that gold could be found in England, Mammon acknowledges that England yields primarily base metals that then potentially can be transmuted into precious ones. While Mammon elides the reality of English metals by planning to transmute them, in specifying his raw materials, he reveals the variety of metals and metalworking, as well as the economic lines of connection implicit in early modern England.

SURLY:

*Why, I have heard, he must be homo frugi,
A pious, holy, and religious man,
One free from mortal sin, a very virgin.*

MAMMON:

*That makes it, sir; he is so. But I buy it;
My venture brings it me.
(2.2.97-101)*

Drawing Mammon on, Surly mentions that he who possesses the philosopher's stone must be a "*homo frugi*," a pious or religious man, in order to draw attention to Mammon's unfitness to receive such a prize. Mammon responds that, as a *client*, he need not be of sound character, a requirement that applies solely to the *maker* of the stone. In distinguishing between buyer and maker, Mammon illuminates an important distinction between patron and laborer that permeated the metal trades. Mammon's quest for the philosopher's stone points not simply to a satirical treatment of corrupt alchemists and

their dull-witted clients, but to the standard way of doing business in the metalworking industries—by proxy. Metal men were essentially middlemen whose engagement with subterranean materials usually was carried out in the interests of others—to develop local industries, assess coinage, prospect for metals, and produce armaments. Slightly different from the putting-out system, the centralized outsourcing of manufacturing (especially of wool) to highly skilled, household-based laborers, the contracted work of mining involved lessees working the land of the landed gentry. The stakes of mining were not purely financial; politics potentially could come into play as well if a mine bore precious metals, as in the case of a dispute between Elizabeth I and the Duke of Northumberland over the contents of his copper mines.²² Moreover, the English mining and metallurgical industries differed significantly from the prosperous English linen and wool industries because they were extremely underdeveloped and had advanced little since the mining heyday of the early middle ages. Most major projects, even those involving coinage, where the stakes are high for national security and prosperity, required importing expertise from Germany. For instance, in 1561, Elizabeth hired German assayers to restore the value of the coinage to a standard of 7.5% sterling silver alloy, a feat her predecessors were unable to accomplish.²³ The landowners who farmed out this work, in turn, were motivated by monopolies granted by the Crown to develop these resources. The system of monopolies allowed the Crown to invest nominally in an industry that benefited the entire commonwealth. The above exchange between Mammon and Surly gestures toward a larger trend in the metal industries, which consisted of a multi-layered process of displaced interests: from worker to overman to landowner to Crown. Bringing to the surface this multi-layered process underscores the fact that alchemical satire about

transmutating metals—in the playhouse as elsewhere—necessarily glossed over *and invoked* the actual metal processing industries in England. This dual status of alchemical satire vis-à-vis metalworking practices is important because it both circumscribes English imaginings of the relation between metals and the self within a discourse of vain and futile actions while locating the productive aspects of that relation within a utopic dream that was more attainable than commonly thought.

The blurring between alchemy and metallurgy was most evident in the cross-section of metal practitioners. These included the “empirics,” ignorant charlatans like Subtle who followed recipe books and frequently conned unsuspecting customers; mining and metallurgical professionals such as Samuel Hartlib’s protégé Gabriel Plattes, who limited their work to the technological application of alchemical principles, but used the purported ends of alchemy to justify the utility of their work to the public good; and alchemical experts *adepti* such as Royal Society members Robert Boyle and George Starkey, self-described serious investigators who used both Paracelsian theory and metallurgical practice to uncover the secrets of nature under the auspices of the Royal Society.

The range of practitioners present in the metalworking fields is mirrored in the variety of social groups participating in them. Even in the rural setting of the mining districts of England, all social groups participated in the metal trades. The Sheffield region, famous for its iron tools, has probate records indicating the involvement of the landed gentry, yeomen, husbandmen, and craftsmen in the metal trades.²⁴ Like Mammon, who hires Subtle to create the philosopher’s stone, landowners, who usually did not possess either theoretical or practical mineral knowledge, hired overmen to oversee the

working of the mine. These overmen, in turn, hired workers to undertake the necessary processes of digging, transporting, and washing the ores. In the case of the coal mines of Whickham, most of the workforce employed at a mine was comprised of the “servants” and the “workemen” of a landowner.²⁵ The “servants” of a landowner were usually trusted middlemen or “overmen” who, for a percentage of the profits, made logistical arrangements, such as the hiring and management of the “workemen.” These “workemen” were usually poor local or transient laborers who physically labored in the mines in the off-seasons of their primary source of employment, pastoral farming.²⁶ This organizational structure permeated Elizabethan and Stuart mining industries.²⁷

The “servants,” or overmen-- often yeomen or lower gentlemen-- who managed the mines of landowners enjoyed better working conditions and a higher social status than that of the workmen they oversaw. Sir William Sidney employed local yeomen farmers and lower gentlemen to run his Sussex ironworks, established in 1539.²⁸ Tin-mine or stannery workers in Devon were granted special privileges, thereby encouraging a sense of community among them.²⁹ Some overmen achieved a degree of status because of their specialized knowledge of mining. For example, Thomas Surtees, who directed the Grand Lease works during the 1610s, was described as “a gentleman expert and skilfull in Mineralls.”³⁰ In France, the status of metalworkers was much higher than that of English metalworkers. For instance, in 1516, Francis I conferred a special social status on the “*maître des forges*” on account of his knowledge among those ignorant of mining affairs.³¹ In England, perhaps because of a general lack of knowledge about mining affairs, aliens often occupied this position between workers and landowners. Most famously, German mining engineers such as Daniel Hochstetter and English supervisors

such as Thomas Thurland oversaw the Duke of Northumberland's copper mines under the behest of a monopoly granted by Elizabeth.³² The middling level of overmen, therefore, proved crucial to bridging the knowledge gap between the workers' tacit understanding of their roles and the landowners' desire to yield a profit from lands rendered unarable by mining. As proxies of metallic skill, these overmen, furthermore, demonstrate that technology can have a productive, and not simply a repressive, effect on the self.

Landowners were comprised of both peers to the Crown and gentlemen, who were more likely than yeomen to exploit the mineral resources of the land.³³ Some notable mine-owning nobles included the Sidneys, who owned an ironworks in the Weald of Sussex in the mid-sixteenth century; the Earl of Shrewsbury, who had holdings in Shropshire in the 1560s; the Earl of Rutland, who had lands in Rievaulx in the 1570s; the Earls of Leicester and Northumberland, who owned copper mines; and Robert Cecil, Earl of Salisbury, who had shares in the Mines Royal and Royal Mineral and Battery Works, as well as investments in mineral prospecting along the Scottish border.³⁴ While not initially a reliable a source of income, mining by the Restoration became a source of non-agricultural income for the landed gentry.³⁵ The investments of the landed gentry in mining and metallurgical projects played a major role in the development of these industries.

Peers such as the Earls of Rutland and Northumberland exercised their mineral rights over their land, a move that often resulted in conflicts between them and the Crown; such conflicts often were resolved with the Crown's issuing of letters patent, which were grants to monopolize a particular industry or trade.³⁶ A 1566 lawsuit between

the Earl of Northumberland and the Crown over the contents of a mine spurred Elizabeth to institute in 1568 the first company for the production of domestic manufactures: The Society of the Mines Royal.³⁷ This company, created shortly after the Muscovy Company, which traded abroad for gold, marked the first organization erected for the management of royal claims to precious metals in mines and for domestic manufactures.³⁸ Shortly thereafter, the Royal Mineral and Battery Works received a patent to develop the technologies of drawing brass into wire and pounding copper metal into thin sheets to make pots. In 1574, the Earl of Leicester, Lord Burghley, Sir Thomas Smith, and Sir Humphrey Gilbert banded together to form the Society of the New Art, which aimed to use alchemical transmutation to convert iron into copper rather than the expected product of gold, as projected by satirical treatments of alchemy.³⁹ The involvement of the aristocracy in both the alchemical and mining arts speaks to the pervasiveness and legitimacy of the metallic arts in early modern England.

Landowners and royal officials were able to negotiate a stake in such endeavors because they often read about technical affairs in printed books. Upon hearing of the ore found on Baffin Island by one of Martin Frobisher's men, Sir Philip Sidney asks his confidant, the diplomat Hubert Languet, to "describe the most convenient method for working those ores. [...] For we understand this art little better than we do the cultivation of vines."⁴⁰ Languet advises him "to read the works of Georgius Agricola, on the origin and causes of subterraneous formations and on the working of mines," describing Agricola as "a most eminent philosopher" who had "far surpassed all who had written on these subjects before him."⁴¹ For someone of Sidney's standing to learn about such processes through texts was a relatively recent phenomenon. Starting in the early

sixteenth century, technical practitioners in Italy and the Holy Roman Empire had begun to put their secret knowledge in a methodical format, printing it under the auspices of a wealthy patron. Gabriel Plattes, a protégé of Samuel Hartlib, explains his *Discovery of Subterraneall Treasure* (1634) as an attempt to render mining, which was once done “by meere accident” into something done with “rules and directions.”⁴² The same move to standardize knowledge is one of the reasons that Elizabeth sponsored the Society of the Mines Royal. The Crown, by granting letters patent to individuals for the development of a specific industry, acted as an indirect patron. Under the auspices of publication, practitioners in the mechanical arts forged alliances with political powers in what was to become a mutually legitimating two-way relation; the writer-patron relation lent authority to the contents within the technical texts, and the technical knowledge arguably could be used to further political ends.⁴³

Books about technical matters allowed humanistically-trained royal administrators and wealthy landowners to exercise their duties to the commonwealth and to create enormous wealth—all without soiling their hands.⁴⁴ Derived from the experience of actual practitioners of the metallic arts, disseminated by an expanding book trade, and consumed by nobles and royal administrators, these texts, in their very existence, demonstrate the very division between labor and capital in the metalworking industries that Mammon invokes in his distinction between he who *buys* and he who *makes* the philosopher’s stone.

FACE:
Why, now, you smoky persecutor of nature!

*Now do you see, that something's to be done,
Beside your beech-coal, and your corsive waters,
Your crosslets, crucibles, and curcubites?
You must have stuff, brought home to you, to work on.
And yet you think, I am at no expense
In searching out these veins, then following them,
Then trying them out. 'Fore God, my intelligence
Costs me more money, then my share oft comes to,
In these rare works.
(1.3.100-108)*

Face's description of his and Subtle's trickery in terms of alchemy—"You must have stuff, brought home to you, to work on"—suggests that alchemy is an inherently deceptive practice; but, Face, frustrated that Subtle refuses to recognize the effort involved in bringing home the "stuff" of clients, describes his efforts by deploying metaphors drawn from the practical idiom of mining and metallurgy: "And yet you think, I am at no expense/In searching out these veins, then following them,/Then trying them out." Face's conceit separates the hard labor of prospecting, mining, and assaying from the relatively easy alchemical "work" of mixing and concocting metallic solutions in glassware and crucibles. Face's complaint echoes the sentiments of Vannuccio Biringuccio, a sixteenth-century metallurgist who in his *Pyrotechnia* advocates "follow[ing] the path of mining more willingly than that of alchemy, even though mining is a harder task, both physical and mental, is more expensive, and promises less at first sight and in words than does alchemy."⁴⁵ While Face obviously does not invoke the superiority of mining and metallurgy in earnest, his use of the conceit of mining to emphasize the particular "work" involved in bringing home "stuff" draws attention to the sheer physical difficulty of mining and metallurgy.

The importance of the physical arduousness of mining and metalworking stems, in part, from the reason why Face makes the comparison between sniffing out the "stuff"

of trickery and the “stuff” of mining in the first place: because Face and Subtle, in effect, conflate people—the “stuff” of their deception—with the movable property and money, or “stuff,” those people supply them in exchange for their alchemical services. This conflation between human and non-human “stuff” is well in keeping with the early modern connotations of the word.⁴⁶ Particularly relevant is Mammon’s “stuff”—“all that is metal, in [his] house.”⁴⁷ This pile of metal goods, which includes andirons, jacks, spits, and a shoe horn, in theory tests the efficacy of Subtle’s imaginary stone, but literally provides the “stuff” that allows Face and Subtle to trick their other clients: Ananias and Tribulation, who believe the goods to be the property of orphans and widows, hope to buy the goods and, using Subtle’s stone, transmute them into gold; Face and Subtle figure they can “work” the “stuff” further by selling it to Abel Drugger, who, they reason, could use the “stuff” to furnish the household he hopes to keep with Dame Pliant. By the end of the play, the goods go to Lovewit, who, finding the goods in his cellar, keeps them despite Mammon’s protests, thereby restoring order and adding wealth to a household formerly bereft of an inventory and a mistress. His renewal of his status as a householder through the acquisition of new “stuff” and a new wife reaffirms the conflation between one’s person and one’s property without benefiting the authors of that conflation, Face and Subtle.

In the mining and metallurgical fields, some truth existed in Face and Subtle’s conflation of material “stuff” and people. Within the discourse of metallurgy, the “stuff” produced in mining and metalworking bore a deep relation to who worked it. This relation, as I explore in chapter two, is one in which the craftsman and the metal come to define each other mutually through the process of working the metal. As the matter in

which a metalworker expresses his will, metal acts as the imprint of an individual's impression; at the same time, the matter of metal defines what the will can act upon. Both will and metal therefore mutually define each other as agent and patient, respectively. It is this relation that Mammon absolves himself of when he distinguishes between the maker and buyer of the philosopher's stone. Face's comments, therefore, reveal a frustration that the value of the "stuff" he produces seems to have no relation to his efforts to produce it. Face's attempts to redeem his contribution by iterating the steps he undertakes recapitulates a belief widespread among the metallic arts: that "stuff" was the result of people's "work," and that this work redounded back on the people who undertook it, conferring legitimacy, and within the hierarchical social system of early modern England, enhanced status. The discourse circulating within the metal fields acknowledged explicitly that the working of metals required the experience and good character of the practitioner. As I will show in chapter two, not only did the quality of human character have an impact on the worth of a piece of ore, but the quality of a metal's substance spoke directly to the quality of the person working that metal. Below, I detail various techniques of the practical metallic arts that both overlap with the satirical appropriation of alchemy and extend it further into a fully developed theory of practices specific to mining and metallurgy.

Throughout this chapter, I have been arguing that Jonson's satirical deployments of alchemy in *The Alchemist* were rooted in the actual facts of the mining and metalworking industries. In this, it joins Geoffrey Chaucer's *Canon's Yeoman's Tale*, the other well-known English example of alchemical satire, in representing accurately some of the beliefs of serious alchemists and in describing replicable processes other than gold-

making, or *chrysopoeia*. The potential fraud involved in *chrysopoeia* derived from the conditions of practicing the art. One of the strategies the alchemist allegedly used to trick people, widely satirized by early modern writers, was to invoke the smokiness of the refining process: under the cover of smoke, a base metal could be switched for gold.⁴⁸ The alchemist was derided for his slovenly smoke-induced demeanor, as in Thomas Lodge's *The Anatomie of Alchymie* (1595), which describes alchemists as "besmeer'd with cole-dust, from their furnace brought."⁴⁹ Calling attention to the messiness of alchemical work therefore allows the alchemist to distract his unwitting client, as Biringuccio describes in his *Pyrotechnica* (1540): "under this veil these men pretend to have a great secret and puff up their reputations by telling lies which deer could not leap over."⁵⁰

Alchemists also were derided for using obscure terminology to give the appearance of being learned. When Subtle states that the stone is "not perfect" and "that the work wants something" (4.3.69), Surly understands the commonplace alchemical reference to "perfection" to mean that Subtle and Face will request more materials, a tactic common among alchemists to buy themselves more time and money from their clients.⁵¹ In Chaucer's *Canon's Yeoman's Tale*, the yeoman, disgruntled by his former master's craft, describes the vanity of alchemy in terms of its excessive and useless subtleties: "Al is in veyn, and parde! Muchel moore./To lerne a lewed man this subtiltee—/Fy! spek nat thereof, for it wol nat bee:/And konne he letterure, or konne he noon,/As in effect, he shal fynde it al oon."⁵² Similarly, Surly remarks that Subtle's use of alchemical terms resembles "canting" (4.3.42), which refers to the hypocritical lecturing on moral matters stereotypically associated with Puritans of the time. As a

gamester himself, Surly detects that Subtle and Face use alchemy as a “pretty kind of game” (2.3.180) to “cheat a man/with charming” (180-1) and pull Jason’s golden fleece, as it were, over the gulls’ eyes. The figures of both messy working conditions that obscure what is actually going on and complicated language that obscures linguistic meaning both emphasize the inherently fraudulent nature of alchemy.

Nonetheless, each of these suspect aspects of alchemy—the coal-smeared demeanor, the constant delay of results in the name of “perfection,” and the use of obscure terms—were not simply tricks. They were also the actual conditions of productive, honest metal processing. In fact, the very *chrysopoetic* processes assumed now to be false were taken seriously even by practical metallurgists such as Biringuccio. He criticizes *chrysopoeia*, but not because he considered it unscientific or mystical; rather he is frustrated at being unable to replicate the process himself: “I could still discourse profusely concerning this art of transmutation, or alchemy as it is called, yet neither through my own efforts nor through those of others (although I have sought with great diligence) have I ever had the fortune to see anything worthy of being approved by good men.”⁵³ His complaint, then, lies not in the purported magical nature of the process, but in the difficulties of completing a chemical process that requires pristine conditions.⁵⁴ Similarly, Francis Bacon, who typically has been understood as rejecting Aristotelianism in favor of an inductive, experimental scientific method, did not reject completely the possibility of transmuting metals. Rather, in *The Historie of the Dense and the Rare*, he argues that the “manufacture of gold, or the transmutation of metals into gold” was “to be much doubted of” because of the known limitations in condensing lighter substances into gold, the heaviest substance then known. He does not entirely dismiss the possibility of

transmutation between base and noble metals because he believes that “the conversion of quicksilver or lead into silver (which is rarer than either of them) is a thing to be hoped for; since it only implies fixation, and some other things, but not condensation.”⁵⁵

Bacon’s call for further research on the question of condensation suggests that he hasn’t completely ruled out the possibility of transmutating metals into gold: “There should be an inquiry touching mines in general [...] In short, everything pertaining to them should be examined, to discover by what means the juices and spirits of the earth are united or compressed into that metallic condensation, which so far exceeds all others.”⁵⁶ According to Bacon, ignorance about the mechanism of metallic condensation may be the only thing preventing the artificial replication of the earth’s natural process of creating gold. The caution toward *chrysopoeia* that both Bacon and Biringuccio exhibit does not signal a reactionary hatred of an unscientific alchemy, but rather provides a moment for pause, reflection, and experiment about the true nature of metals.

One hindrance to a widespread understanding of the mechanism of *chrysopoeia* was the infamous secrecy attached to alchemical texts. Prior to its presence in print, most craft knowledge was considered secret. As William Eamon has shown, secrecy was a rhetorical strategy used by various purveyors of knowledge as a means of protecting knowledge, as a limitation to the scope of scientific inquiry, and as a way of conferring erudition on a body of knowledge.⁵⁷ William Newman and Lawrence Principe similarly argue that a “culture of concealment and secrecy” was prevalent among practitioners of seventeenth-century chymistry such as George Starkey, the colonial counterpart to Robert Boyle who popularized Van Helmontian chymical ideas to the English public.⁵⁸ Secrecy

lent an air of erudition to chemical texts as well as prevented their contents from being interpreted by any but the most skillful of readers.

At the same time, the difficulty of many practical metal texts did not necessarily stem from a desire for secrecy. Since most of the metallic arts had developed in concert with the transfer of German experts to England, many of the terms were simply foreign. One of the earliest printed books on mining, Georg Agricola's *Bermannus*, depicts a conversation between a philologist and a miner in which the expertise of both is necessary for understanding a metal. The publication of this text required, however, an appended word-list that defined the "terms of art" comprising the expertise depicted in the text.⁵⁹ Similarly, Martin Rulandus' *Lexicon of Alchemy* (1612) is an early example of an aid for Hermetic texts. Michael Sendivogius, in his *New Light of Alchymie* (1650), "added a Chymical Dictionary, explaining hard places, and words met withal in obscure Authors." Thomas Houghton's *The Compleat Miner* (1681), a practical handbook for miners and mining law suits, includes an "Explanation of the Miners Terms of Art." John Pettus' *Fodinae Regales*, a history of the Society of the Mines Royal, is supplemented with an "explanation of several Words used in this History." Pettus' *Fleta Minor*, a translation of Lazarus Ercker's *The Art of Assaying*, includes the first English mining dictionary, called an "Essay on Metallick Words." Developed in response to the conditions of publication, these reading aids for mining and metallic texts give credence to the inherently and legitimately difficult nature of understanding the metallic arts; they both provide the basis of, and undermine, the satirical understanding of alchemy as a deceptively obscure art.

The difficulty in reading texts about metals was not merely a function of translating foreign terms or coining “hard words”; in addition, the practical difficulties of obtaining metals from the earth informed the difficulties of writing about metals. In *The Historie of the Dense and the Rare*, Francis Bacon limits a table of the densities of substances to what lies above the ground: “Of things in the interior of the earth however I say nothing, seeing that they are not subject either to sense or experiment. These, it may be, being both far removed and completely separated from the heat of the heavenly bodies, are more dense than any known bodies.”⁶⁰ The Earl of Sandwich describes his translation of Alvaro Alondo Barba’s *The Art of Metals* (1674) as a “Jewel so rare that few had it to sell, for it was concealed like the great Arcanum.”⁶¹ Barba explains theoretical controversies over the generation of metals as an effect of their inaccessibility: “It is no wonder, that learned men differ so much in their opinions, about the matter whereof Mettals are engendred, because the Author of Nature seems to have created them in that obscurity, and depth, and to have immured them with hard Rocks, on purpose, to hide their causes, and to give check to the ambition of Man.”⁶² In his *Metallographia* (1671), John Webster explains the relative lack of knowledge about metals in terms of their inaccessibility: “[metals,] being a thing lay hid in the bowels of the Earth, whereinto the senses of few men could pierce; and so exceeding difficult to observe or understand, that it is no great marvel that so little progress is made into that kind of Knowledg[e].”⁶³ He describes those who do succeed in making progress in mineral knowledge as having “with Herculean boldness, and undaunted resolution, broken through all difficulties, and adventured great dangers and long peregrinations for attained fame, more (perhaps) then Jason for the Golden Fleece.”⁶⁴ The obscure locations in which metals were found, in

addition to concerns about maintaining secrecy, contributed to the difficulties of knowing about metals.

In response to the physical and financial difficulties in locating metals, the mining and metallurgical fields gradually developed a system of signs for determining where ore was located. In many ways, these tactics are rooted in alchemical practices but also depart from them. Biringuccio writes in his *Pyrotechnia* that the best way to “discover ores” is to “abandon the way of bestial and fearless men and to choose “signs that are exhibited to us through the benignity of Nature.”⁶⁵ Such signs, in turn, allow a miner to “make certain inference that such a mountain contains ores, and as the signs are more or less, so are the minerals plentiful and rich or poor.”⁶⁶ A defining characteristic of such signs was that they be obvious enough to recognize. Manuals such as Gabriel Plattes’ *A Discovery of Subterranean Treasure* advised its readers “to find the strong signes which may rightly guide the seekers to obtaine their desire.”⁶⁷ Writers attempted to make these mineral signs all the more obvious to the inexperienced by comparing them to the vegetable and animal worlds. Biringuccio explains that ores are located underground in areas that resemble “veins of blood in the bodies of animals, or the branches of trees spread out in different directions.”⁶⁸ Situating the veins of ores within the geological body, Alvaro Alonso Barba, in *The Art of Metals*, describes these veins as “running through the “great body” of the Earth and acting as “principal receptacles” of the Earth’s humidity, which is “as blood is in the bodies of Animals.”⁶⁹ Not only does the location of ores borrow from the living world, but the way in which they emerge to the earth’s surface resembles the growth of vegetables. Biringuccio describes the metallic signs, or “fumositie,” that emerge at the surface of a mountain as the culmination of a vegetative process taking

place underground: “finally the tips arrive at the summit of the mountain and emerge with clear sign, sending forth, in place of leaves and blossoms, blue or green fumosities, marcasites with small veins of heavy mineral, or other composition of tinctures.”⁷⁰

Gabriel Plattes similarly alerts prospective miners to keep their eyes peeled for grass-colored signs, marcasites, and even the barren surfaces of mountains, which give a “greater probability there is that they containe rich Mines and Minerals.”⁷¹

Such signs, in turn, are persuasive not simply because they look a certain way but because they represent the accumulated experience of knowledgeable people who have interacted with the world. Biringuccio describes the signs he recounts as “approved by all experts because of their experience,” a point that distinguishes the experts from the necromancers— “bestial and fearless men”— who rely on “words or promises of incomprehensible and vain things.”⁷² When looking for signs, a miner must “penetrate with eyes of appraisal and judgment within the mountains and see almost exactly the places where there is ore.”⁷³ In the event that no obvious signs are visible, as in the case of the barren mountaintops mentioned above, a miner must, according to Biringuccio, keep his “eyes and ears turned to wherever there is hope of finding some information, especially toward shepherds or other ancient inhabitants of the countryside.”⁷⁴ Once a miner has found the appropriate signs of ore and has confirmed the truth of those signs with local informants, then the miner needs to exhibit specific qualities appropriate to the difficult task at hand. Biringuccio advises miners to exhibit “courage and patience,” “applying [their] skill with a determined spirit and judgment, because in this work these qualities serve [them] in place of eyes to penetrate where [their] eyes cannot reach.”⁷⁵ In other words, although the signs themselves point miners in the right direction, without a

certain temperament and resolve, miners cannot expect to find any ore because their eyes will fail them underground.

Regardless of the type of ore, a miner could be assured that he would not find a naturally refined ore; most ores were a mixture of a number of metallic ores. Barba describes “all the inanimate things within the bowels of the Earth” as reducible into “Four Kinds of mixtures [...] Either Mettals, Stones, Earth or Juices.”⁷⁶ Interestingly, mixture itself was not a negative attribute; rather, uneven mixing was. For instance, metals such as silver often were mixed with copper and lead to the point that the expenses incurred in extracting the silver could outweigh the value of the metal itself.⁷⁷ Gold, on the other, hand, was considered a “perfect and uniform elemental mixture,” an attribute that, combined with its “thorough tempering” underground, gave it a dense consistency.⁷⁸

Since only gold could boast a perfect mixture, most other metallic ores had to be separated from their constitutive parts with the assay, which would require the repeated heating, or fining, of an ore sample until each part had been separated. Metallurgists and chymists alike regarded the assay as not simply a common technique, but a method of finding truth in the metallic world. Lazarus Ercker describes “Assaying, Proving, and Refining of Metalls” as an “Excellent, Noble Science [...] long since found out by the Art of Alchimy and Chimistry.”⁷⁹ Biringuccio describes the assay as the “discovery of false Gold and Silver from that which is good, and to know the true value thereof.”⁸⁰ Similarly, Barba explains, “the true knowledge of what species the Mettal is depends upon the ensaying of the Oar.”⁸¹ The assay brings not only the “truth” of a metal to the fore, but discovers “many good and rich mines [...] which otherwise would have lain concealed.”⁸²

The commingling of the language of “truth” and finances makes assaying not a “disinterested” discovery of nature, but a highly interested, indeed political, one.⁸³ After the failure of his currency reforms in 1604 (which privileged gold over silver, thereby devaluing silver coin and contributing to inflation), James I grew suspicious that goldsmiths responsible for assaying the coinage in previous years had engaged in fraud. James, therefore, used the ceremony of the Trial of the Pyx to assert his authority over the value of coinage and the goldsmiths and assayers previously responsible for managing that value, thereby turning the creation of value itself through the metallurgical assay into a spectacle of royal power.⁸⁴ Similarly, the Guinea gold trade of the late seventeenth century, instituted to restore the royal coffers depleted by the Civil War,⁸⁵ further transformed the metallurgical assay into an emblem of honest dealing.⁸⁶ Perhaps attempting to redeem the association between the knowledge of metals and the profitable nature of mining, manuals of mining and metallurgy urged that refiners be upright Christian gentlemen.⁸⁷ William Badcock, a London goldsmith, goes as far as to describe the assay as “a subject fit for the study and practice, not only for all Goldsmiths, but for all Gentlemen, to the end the general knowledge herein may the better prevent so great and frequent deceits in Gold and Silver works.”⁸⁸ Badcock’s affiliation with the “great and frequent deceits” prevalent in the processing of precious metals elevates an otherwise mundane activity into something that requires the utmost honesty. Barba insists that a refiner undergo “strict examination of his sufficiency” in terms of both his character, which should be “well furnished with the honor of a Christian,” and his knowledge of “the Art of Refining.”⁸⁹ Barba advises that such a Refiner should “know all sorts of Mettals, their qualities and differences” and the “lesser Ensay by the Fire,” a process

more arduous than refining by mercury or quicksilver because it requires that the refiner “should never give over making trials, until he hath obtained [the desired metal].”⁹⁰

Considering all the mishaps that can occur during a trial, none exceeds the negative influence of “a Refiner of a wicked Conscience.”⁹¹ Barba’s caution stems from the notion that the nation puts “a very great Trust” in the hands of Refiners, who “without account” control the “whole Riches” of the nation.⁹²

Assayers partially earned the respect of the mining and metallurgical trades because they could manipulate fire to change material substance. The fifteenth-century invention of the blast furnace, by allowing for higher temperatures than ever before, facilitated the melting and casting of impervious base metals such as lead and iron, thereby expanding knowledge about the possibility of transmuting metals from base to noble.⁹³ Artificially cultivating such intense heat gave metalworkers the wherewithal to compete with the natural heat of the sun, the stars, and the earth. The distinction between natural and artificial heat had ideological import as well as is attested prominently in Jonson’s *Mercury Vindicated from the Alchemists’ Court* (1615), which stages a conflict between two sources of heat: the natural heat of the sun and the artificial heat of the furnace.⁹⁴ By using artificial heat, the alchemists in Jonson’s masque claim superiority to the natural heat of the sun, which is embodied in King James, dubbed the “Sun King.” In thematizing the productions of alchemists within the space of the antimasque, Jonson would seem to denigrate such artificial creation of value in the face of James’ self-affirming sun-like energy; but, the status of the antimasque as a “foil” to the main masque implies a relation of mutually reinforcing meaning between the two forces of the sun and the furnace.⁹⁵ In his “Essay on Metallick Words,” John Pettus, a lieutenant governor of

the Society of the Mines Royal, describes alchemy as an art that uses fires both natural or “celestial” and artificial or “culinary,” a reference to the digestive realm of eating that underscores the connection between the macrocosm of the earth and the microcosm of the self implied by metal-mettle. The ability of assayers to replicate artificially the natural heat of the sun, and in so doing, circumscribing the very definition of what constituted the “natural,” contributed to their high status within the metalworking fields.

The notion that alchemy partook of both artificial and natural heat stemmed from a number of theories ranging from Neoplatonism to Aristotelian naturalism to Paracelsian vitalism.⁹⁶ Common to all three theories was the idea that the material and spiritual worlds affected each other. In Aristotelian terms, the heat generated by artificial, culinary fires was considered analogous to that of the sun, which warmed the earth, causing “exhalations” to emanate from the base metals there incased.⁹⁷ For example, in *A Discovery of Subterraneall Treasure*, Gabriel Plattes explains the Herodotean commonplace that gold and silver were found in hot climates in terms of cookery: “And the reason why the hotter the Country is, the richer the Minerals are, can be no other but the same, that roasted meates are sweeter than boyled meates, or raw meates: the reason whereof is plaine, for that the rawish and unsavoury part is exhaled by the heate of the fire, leaving the sweeter part behind.” Yet Plattes does not allow culinary heat to supersede solar heat, a claim that would suggest that he thought it possible to transmute base metals to noble; rather, he discounts the idea that “the substance of the best metals” can be created by “heate and digestion” alone because the “matter of substance” of base and noble metals are “quite contrary” to each other, a fact that would make any attempt to turn one into the other a process involving “much labour, charges, and losse.”⁹⁸ To prove

his point, he documents an experiment that attempts to convert a base metal to gold using a mixture of iron and copper. After taking considerable pains to melt the base metals with an amalgam of silver and mercury, or quicksilver, Plattes sets the concoction “in gentle heat about a week, then in very strong heat for 6 houres,” repeating the process “till such time as that it [the quicksilver] had carried up all the silver from the bottome of the glasse into branches like trees.” After fining the silver yet again and parting it with nitric acid or “Aqua-fortis,” Plattes successfully produces “divers graines of pure & good gold abiding all tryalls” whose “quantity would not pay for halfe the charges and labour.”⁹⁹ Plattes’ efforts reveal that although the new artificial heat generated by the blast furnace inspired comparisons to the natural heat of the sun, it ironically undermined, through metallurgical practice, theories regarding the transmutation of lead to gold.

While the actual technology of the blast furnace advanced metallurgical practice, it alone was useless without the experience of manipulating a fire. In his *Fleta Minor*, a translation of Lazarus Ercker’s *A Treatise of Assaying and Ores*, John Pettus describes the “government of the fire” as one of the hallmarks of an “experienced Assayer.”¹⁰⁰ Translating from Ercker a description of an assay oven made of armour plate rather than the standard material of clay or loam, Pettus argues that skill supersedes equipment. He exhorts the reader that although “there is much Estimation made” of the armour-plate oven, “there can be no more accomplished with it” than with the others unless “the Assayer have well the knowledge of the Fire, after which all Proofs are to be governed.”¹⁰¹ Pettus describes such knowledge as something “learned only out of much Experience,” a point that overconfident, “young Assayers” seem to ignore because they “much esteem their own Works” while “slight[ing] knowledg of the fire.”¹⁰²

“Knowledge of the fire” proves important in assaying because of the high risk of losing metallic content during the process. A common difficulty involved knowing exactly when to remove a cupel from the fining oven because if left for too long, the metal would be absorbed in the walls of the cupel along with the waste or slag. For example, in a chapter on melting and casting a type of copper, Pettus emphasizes the necessity of knowing “how to give heat and cold” because “if it is not so, and that the tryal be too hot, then there will be an ounce of Silver less in a Centner of rich Copper, and the Contents be found so much poorer.”¹⁰³ The high stakes of regulating the temperature of a furnace did not escape Daniel Hochstetter either, the German manager of the Royal copper mines in Keswick and one of the patentees of the Society of the Mines Royal. In a notebook attributed to him, Hochstetter instructs his readers to assay copper ore “with a strong fire and blast[,]” but to remove it once the ore appears “clean in your crucible” or else “if you keep it too long in the fire your copper will waste.”¹⁰⁴ Such difficulties in managing fires, in fact, convinced Biringuccio that the transmutation of metals by artificial means was unlikely since “we do not know how to proceed in administering heats that are identical with natural ones.” Biringuccio writes off the difficulties of maintaining fire as a commonplace excuse that alchemists rely on to delay producing results. He recounts an alchemist who blamed the failure of his experiment, “in which the substance of his materials had been burned and the spirits inadvertently allowed to escape,” on his having “been deceived by the excessive strength of the fire.”¹⁰⁵ The extent to which an assayer can handle the fire speaks to his experience.

These illustrative moments from *The Alchemist*—Face’s metallurgical complaint, Mammon’s distinction between buyers and makers of the philosopher’s stone, and his promise to transmute all of England’s base metals into gold—all demonstrate in various ways the relevance of the satirical view of alchemy to the actual English metalworking trades. Face’s distinction between working on the stuff of metals and processes leading up to that point reveals a way of knowing distinct to the metalworking fields—one that posits a relationship between the “stuff” of a metalworker and the products of his or her labor. By taking into account the experience of a metalworker, we can begin to appreciate that the practical mining and working of metals reveal an intimate connection between the experience embedded within a person and the quality of a piece of metal or ore. The detailed process by which this connection is forged into a tight analogy between subjects and objects, persons, and things, is the subject of chapter two. For now, what is important to note is that the material practice of metalworking—methods such as tending a furnace, assaying metals, separating and prospecting for ores—typically are described in such a transparent manner. The transparency of metalworking processes depends, in part, on the specific social structure organizing the culture of metals. In particular, the middling figure of the overman is responsible for translating metallurgical knowledge to landowners; the same transparency also occurs in metallurgical texts representing the alliances forged between these middling types and their wealthy patrons. This open communication of techniques distinguishes the discourses of practical metalworking from the *chrysopoetic* arm of alchemy, whose discourses tend toward secrecy and obscurity. It is in part because of its lack of transparency, its impermeability to understanding beyond the circles of experts, that alchemy was so vulnerable to satire—especially within the

literary imagination, which takes so seriously the connection between words and things. More often than not, early modern literature figured alchemy as a synecdoche for a diverse body of metallic theory and practice, and tarred all aspects of practical metalworking that bore a resemblance to the satirical vision of alchemy—such as difficult terminology and messy working conditions—derived from the actual conditions of labor conducted not deceptively, but in earnest. Face’s equation of his own belittled work of prospecting for dupes with mining and metallurgy reveals an underappreciated aspect of metalworking—the honest labor involved—in a society whose literary imagination tends to reduce alchemy to the dishonest transmutation of base objects into gold.

¹ This and all subsequent references to Ben Jonson’s *The Alchemist* and his masques will be cited parenthetically in the body text and are in *Ben Jonson’s Plays and Masques*, ed., Robert M. Adams (New York: Norton, 1979), 176-274.

² For a reading of *The Alchemist* as Jonson’s critique of Tudor era theatrical taste, see David Riggs, *Ben Jonson* (Cambridge, MA: Harvard University Press, 1989), 172-5; for the opposing view, that the text of Jonson’s plays presumes a sophisticated audience and that Jonson’s critique of theater culture represented his attempt to make lower artistic forms such as the comedy more serious, see John Creaser, “Enigmatic Ben Jonson,” in *English Comedy*, eds., Michael Corder, Peter Holland, and John Kerrigan (New York: Cambridge University Press, 1994), 101, 103; for the view that Jonson’s use of alchemy is a commentary on dramatic technique, see Michael Flachmann, “Ben Jonson and the Alchemy of Satire,” *SEL* 17.2 (1977): 259-80; for the view that Jonson examines the theatrical arts through not simply alchemy, but other practical epistemologies such as astrology, industrial projects, and applied mathematics, see Henry Turner, *The English Renaissance Stage: Geometry, Poetics, and the Practical Spatial Arts 1580-1630* (New York: Cambridge University Press, 2006), 265-74. For readings of the play as evidence of a broader interest in alchemy see: Charles Nicholl, *The Chemical Theater* (Boston: Routledge, 1980); and much earlier, Edgar Hill Duncan, “Jonson’s *Alchemist* and the Literature of Alchemy,” *PMLA* 61.3 (1946): 699-710.

³ Dud Dudley, *Metallum Martis* (London, 1665), sig. A4^r.

⁴ Other readings of the play also argue that *The Alchemist* comments on the actual conditions and location of the Blackfriars playhouse: for a reading of the Blackfriars setting of the play as both a commemoration of the King’s Men’s recent transfer to the new playhouse and a depiction of the rivalries among theater companies, see Anthony Ouellette, “*The Alchemist* and the Emerging Adult Private Playhouse,” *Studies in English Literature* 45.2 (2005): 375-99; for a reading of *The Alchemist* as a reflection of the plague conditions in London, see Riggs, 169-172.

⁵ Simon Wortham, "Sovereign Counterfeits: The Trial of the Pyx," *Renaissance Quarterly* 49.2 (1996): 334-359.

⁶ Robert Baldwin, "Speculative Ambitions and the Reputations of Frobisher's Metallurgists," in *Meta Incognita: A Discourse of Discovery*, edited by Thomas H.B. Symons (Hull, QE: Canadian Museum of Civilization, 1999), 401-476; Bernard Allaire, "French Reactions to the Northwest Voyages and the Assays by Geoffroy Le Brumen of the Frobisher Ore (1576-1584)," in *Meta Incognita*, 589-606.

⁷ For the view that early modern satire about immoral profiteering in industry belies the actual growth and capital-heavy investments made by aristocrats in the metallic industries, see Brian Gibbons, *Jacobean City Comedy* (New York: Methuen, 1980), 24-6.

⁸ Vannuccio Biringuccio, *Pyrotechnia* (New York: Dover, 1990), 28.

⁹ John Pettus, *Fodinae Regales* (London, 1670), sig. 42^r.

¹⁰ *Ibid.*, 82-90.

¹¹ On the English iron armaments industry, see G. Hammersley, "The State and the English Iron Industry in the Sixteenth and Seventeenth Centuries," in *Trade, Government, and Economy in Pre-Industrial England*, 166-86, eds. D.C. Coleman and A.H. John (London: Weidenfeld and Nicolson, 1976); on the export of lead to the German states, see Ian Blanchard, "English Lead and the International Bullion Crisis of the 1550s," in Coleman and John, 21-44. By the late sixteenth century, the process of reducing ores with mercury, known as amalgamation, rendered English lead unprofitable.

¹² Donald Coleman, *Economy of England* (New York: Oxford University Press, 1977).

¹³ Sybil Jack, *Trade and Industry in Tudor and Stuart England* (London: George Allen and Unwin, 1977), 67-83; T.K. Derry and Trevor I. Williams, *A Short History of Technology* (New York: Dover, 1993), 142; Jack, *Towns in Tudor and Stuart Britain* (New York: St. Martin's Press, 1996), 54; Clarkson, 94; T. S. William, *The Inland Trade* (Manchester: Manchester University Press, 1976), 29.

¹⁴ Carter C. Hudgins, "Old World Industries and New World Hope: The Industrial Role of Scrap Copper at Jamestown," *The Journal of the Jamestown Rediscovery Center* 2006 (2004). See especially section 4, "Documentary Evidence." Hudgins cites the remains of scrap copper and other detritus in the Jamestown colony as evidence of the exportation of copper to the colony for the purposes of smelting brass with possible zinc deposits there. This thesis overturns previous interpretations of the scrap copper as leftover stock from trading with the indigenous population.

¹⁵ Jan Devries, *The Economy of Europe in an Age of Crisis* (New York: Cambridge University Press, 1976), 106.

¹⁶ On the capital-intensive nature of the mining and smelting operations, see Leslie A. Clarkson, *The Pre-Industrial Economy in England 1500-1750* (New York: Schocken, 1971), 99-100; Donald Coleman, *Industry in Tudor and Stuart England* (London: MacMillan, 1975), 41.

¹⁷ Clarkson, 86-7.

¹⁸ Peter Clark and Paul Slack, *English Towns in Transition* (New York: Oxford University Press, 1976), 38-9.

¹⁹ Jack, *Towns*, 141.

²⁰ William, 41.

²¹ Clarkson, 75-6, 82.

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- ²² See M.B. Donald, *Elizabethan Copper: The History of the Company of the Mines Royal* (London: Bergamon Press, 1955) and Eric H. Ash, *Power, Knowledge, and Expertise in Elizabethan England* (Baltimore: Johns Hopkins University Press, 2004).
- ²³ On the details of Elizabeth's restoration of the currency, see Thomas K. Derry and Trevor I. Williams, *A Short History of Technology* (New York: Dover, 1993), 143; on the queen's use of German experts to refine the coinage, see Ash.
- ²⁴ David Hey, *The Rural Metalworkers of the Sheffield Region* (Leicester: Leicester University Press, 1972), 22.
- ²⁵ David Levine and Keith Wrightson, *The Making of Industrial Society: Whickham, 1560-1765* (Oxford: Clarendon Press, 1991), 182.
- ²⁶ Ibid., 183-5, 188; On the farmer-miner, see Barry Coward, *The Stuart Age* (London: Longman, 1980), 15; Alan Everitt, "Farm-Labourers, 1500-1640," in *Rural Society: Landowners, Peasants, and Labourers*, ed. Christopher Clay (Cambridge: Cambridge University Press, 1990), 190n; Joan Thirsk, "Industries in the Countryside," in *Essays in the Economic and Social History of Tudor and Stuart England*, 70-88, ed. F.J. Fisher (Cambridge: Cambridge University Press, 1961), 72-3.
- ²⁷ Levine and Wrightson, 183.
- ²⁸ Joyce Youngs, *Sixteenth Century England* (New York: Penguin, 1984), 239.
- ²⁹ Ibid., 32.
- ³⁰ Levine and Wrightson, 183.
- ³¹ Henry Heller, *Labour, Science, and Technology in France, 1500-1620* (New York: Cambridge University Press, 1996), 15-20.
- ³² Youngs, 242; Joseph U. Nef, *The Rise of the British Coal Industry* (New York: Routledge, 1966), 268. For the details about this patent, see Landsdowne MSS, 5, no. 47. For a detailed treatment of the role of German experts in Elizabethan copper mining, see Ash and Donald.
- ³³ Youngs, 324-5.
- ³⁴ Coleman, *Industry*, 42. Lawrence Stone, "The Fruits of Office: The Case of Robert Cecil, 1st Earl of Salisbury, 1596-1612," in *Essays in the Economic and Social History*, edited by F.J. Fisher, 89-116 (Cambridge: Cambridge University Press, 1961), 89-116, 91.
- ³⁵ Devries, 76.
- ³⁶ Youngs, 332.
- ³⁷ Pettus, *Fodinae*, 20; For a detailed account of this law case, see M. B. Donald, *Elizabethan Monopolies* (Edinburgh: Oliver and Boyd, 1961), 137-45.
- ³⁸ Donald, *Monopolies*, 7.
- ³⁹ For a detailed account of the Society of the New Art, see John Strype, *The Life of the Learned Sir Thomas Smith* (London, 1698).
- ⁴⁰ Sidney to Languet, the Queen's palace, 1 October 1577, *The Correspondence of Sir Philip Sidney and Hubert Languet*, ed., Stuart A. Pears (London: William Pickering, 1845), 120.
- ⁴¹ Languet to Sidney, Frankfurt, 28 November 1577, Pears, ed., 128-9.
- ⁴² Gabriel Plattes, *A Discovery of Subterraneall Treasure, viz. Of all Manner of Mines and Mineralls, from the Gold to the Coale; with plaine Directions and Rules for the finding of them in all Kingdomes and Countries* (London, 1634), sig. B2^v.

⁴³ See Pamela Smith, *The Business of Alchemy: Science and Culture in the Holy Roman Empire* (Princeton, N.J.: Princeton University Press, 1994).

⁴⁴ Ash, 10-17.

⁴⁵ Vannoccio Biringuccio, *The Pyrotechnia*, eds. Cyril Stanley Smith and Martha Teach Gnudi (New York: Dover, 1990), 40.

⁴⁶ See definitions I.g, II.2.a, and II.3.b in “stuff, n.,¹” in *Oxford English Dictionary Online*, 2nd ed., 1989 <<http://www.dictionary.oed.com>> (20 March 2007).

⁴⁷ For the play’s references to Mammon’s “stuff,” see: 2.3.115-121; 2.4.12-13; 2.4.23-4; 2.4.322-26; 4.7.126-7; 5.5.62-74; 5.5.92, 94-5.

⁴⁸ Nicholl, 7.

⁴⁹ Thomas Lodge, sig. 12v, quoted in Nicholl, 8.

⁵⁰ Biringuccio, 241.

⁵¹ See Nicholl.

⁵² Geoffrey Chaucer, *The Canon Yeoman’s Tale*, in *Electronic Text Center*, l. 843-47 (Charlottesville, VA: University of Virginia Library, 2005) <<http://etext.lib.virginia.edu>> (20 March 2007).

Modern English translation (mine):

All is in vein, and by God! Much more

To teach an ignorant man this subtlety

Fie! Speak not thereof for it will not be.

Whether he can read or write is irrelevant;

The result will be the same.

⁵³ Biringuccio, 40.

⁵⁴ See Marcos Martinon-Torres and Thilo Rehren, “Alchemy. Chemistry and Metallurgy in Renaissance Europe: A Wider Context for Fire-Assay Remains” *Historical Metallurgy* 39.1 (2005): 14-28, 24-5, and Smith and Gnudi.

⁵⁵ Francis Bacon, *The Historie of the Dense and The Rare, or the Contraction and Expansion of Matter in Space in Works*, eds., James Spedding, Robert Leslie Ellis, and Douglas Denon Heath, volume 5 (London: Longman, 1858), 346-7.

⁵⁶ *Ibid.*, 345.

⁵⁷ William Eamon, *Science and the Secrets of Nature: Books of Secrets in Medieval and Early Modern Culture* (Princeton: Princeton University Press, 1994), 11.

⁵⁸ William Newman and Lawrence Principe, *Alchemy Tried in the Fire* (Chicago: University of Chicago Press, 2002), 178.

⁵⁹ Owen Hannaway, “Georgius Agricola as Humanist,” *Journal of the History of Ideas* 53.4 (1992): 553-560; 558-9.

⁶⁰ *Ibid.*, 344.

⁶¹ Albaro Alonso Barba, trans., R.H. Edward Earl of Sandwich, *The Art of Metals in which is Declared the Manner of their Generation and the Concomitants of Them* (London: S. Mearn, 1674), epistle dedicatory.

⁶² *Ibid.*, 69.

⁶³ John Webster, *Metallographia: or an History of Metals* (London, 1671), 16-7.

⁶⁴ *Ibid.*, 17.

⁶⁵ Biringuccio, 14.

⁶⁶ *Ibid.*, 13.

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- ⁶⁷ Plattes, 2.
- ⁶⁸ Biringuccio, 13.
- ⁶⁹ Barba, 91.
- ⁷⁰ Biringuccio, 13.
- ⁷¹ Plattes, 9-10.
- ⁷² Biringuccio, 14-5.
- ⁷³ Ibid., 13.
- ⁷⁴ Ibid., 14.
- ⁷⁵ Ibid., 21, 23.
- ⁷⁶ Barba, 2.
- ⁷⁷ Biringuccio, 47.
- ⁷⁸ Ibid., 27.
- ⁷⁹ John Pettus, *Fleta Minor* (London, 1683), sig. A1^r. On the medieval precursors to the early modern assay, see William Newman, "Alchemy, Assaying, and Experiment" in *Instruments and Experimentation in the History of Chemistry*, edited by Trevor H. Holmes and Frederic L. Levere (Cambridge, MA: MIT Press, 2000), 35-54.
- ⁸⁰ Biringuccio, 30.
- ⁸¹ Barba, 98.
- ⁸² Pettus, *Fleta*, sig. A1^v.
- ⁸³ I am contrasting the "highly interested" model of knowledge production in the metallic arts to the "disinterested" knowledge-producing activities of the Royal Society of London as outlined in Steven Shapin's *A Social History of Truth* (Chicago: University of Chicago, 1995).
- ⁸⁴ See Simon Wortham, "Sovereign Counterfeits: The Trial of the Pyx," *Renaissance Quarterly* 49.2 (1996): 334-59.
- ⁸⁵ Pettus, *Fodinae*, 28.
- ⁸⁶ Simon Schaffer, "Golden Means: Assay Instruments and the Geography of Precision in the Guinea Trade" in *Instruments, Travel, and Science: Itineraries of Precision from the Seventeenth Century to the Twentieth Century*, eds. Marie-Noelle Bourguet, Christian Licoppe, and H. Otto Sibum (New York: Routledge, 2002), 20-50.
- ⁸⁷ These attributes resonate with Shapin's description of the Royal Society's ideal of the genteel observer of nature. For a critique of Shapin, see Barbara Shapiro, *A Culture of Fact: England 1550-1720* (Ithaca, N.Y.: Cornell University Press, 2000). On the moral dimensions of assaying and other instruments of precision, see Schaffer.
- ⁸⁸ William Badcock, *A New Touchstone for Gold and Silver Wares* (New York: Praeger, 1970), 31.
- ⁸⁹ Barba, 3, 5.
- ⁹⁰ Ibid., 5, 6.
- ⁹¹ Ibid., 5.
- ⁹² Ibid., 4.
- ⁹³ Derry and Williams, 121.
- ⁹⁴ This and all references to *Mercury Vindicated* are from Stephen Orgel, *Ben Jonson: Selected Masques* (New Haven, CT: Yale University Press, 1970).
- ⁹⁵ On alchemists as foils to James I, see Riggs, 220.
- ⁹⁶ Merchant, 105-26.

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- ⁹⁷ Ibid., 26.
⁹⁸ Plattes, 38-9.
⁹⁹ Ibid., 36-41.
¹⁰⁰ Pettus, *Fleta*, 10.
¹⁰¹ Ibid., 12.
¹⁰² Ibid., 48.
¹⁰³ Ibid.
¹⁰⁴ See Appendix I in Donald, *Copper*, 370.
¹⁰⁵ Biringuccio, 41.

Chapter Two

Assaying English Metallic Skill in the New World

At lengthe, after diverse attempts, he commaunded his company if by anye possible meanes they could get ashore, to bring him whatsoever thing they could first find, whether it were living or dead, stocke or stone, in token of Christian possession, which thereby he toke in behalfe of the Queenes most excellent Majestie, thinking that thereby he might justify the having and enjoying of y^e same things that grew in these unknowne partes.¹

In his *True Account* of Martin Frobisher's first voyage to find the Northwest Passage, George Best recounts a moment prior to the crew's landing on Meta Incognita, present-day Baffin Island. With his ship stuck in the ice surrounding the shore, Frobisher "commanded" his "company" to "get ashore" and gather some souvenirs. Frobisher's apparent lack of preference for what his company would bring back is striking. He does not mind whether "whatsoever thing" they would bring "were living or dead, stocke or stone." As a "token of Christian possession," this unidentified item need not have an identity; rather, its existence alone seems sufficient to "justify" to Queen Elizabeth that "the having and enjoying of y^e same things" warrant a second voyage to Meta Incognita. The "token" in question was "a peece of blacke stone, much lyke to a seacole in coloure, whiche by the waight seemed to be some kinde of metal or mynerall." In its resemblance to sea-coal, an ordinary English source of fuel, this "token" was too mind-numbingly commonplace to have been chosen at random. In this chapter I explore the possibility that the worthlessness of the black stone is not accidental, but emblematic of a particular model of English identity that associates technical skill with noble character.

Because the black stone was discovered in the frigid Arctic, and did not conform to the classical canon of travel (which stated that metals could be found only in hot climates), its identity literally had to be created by being processed in metallurgical assays and circulated within a network of goldsmiths, assayers, refiners, and alchemists. In this chapter, I argue that the English unanticipated encounter with base metals in the New World unexpectedly allows for the display of effort and skill in the metallic arts, in particular, the metallurgical assay, which becomes an emblem of good character and efficacious action in the service of the Crown. As I describe in chapter one, this creation of identity is well within the culture of English metallic practice, which regarded the character and experience of a refiner as essential to the quality of a resultant ore. These displays of metallic skill had the immediate and practical goal of proving the existence of mineral wealth in the New World. The apparent (and later actual) worthlessness of Frobisher's ore, in turn, gives the English a chance to extract readings of their good character from their professed skill and judgment in manipulating the metallurgical assay. Jeffrey Knapp has argued that the utter worthlessness of Frobisher's black stone confirms the English valuing of the small and the trifling, which in terms of New World failures speaks to the English transcendence of the practical.² While I agree with Knapp's assessment of the English love of the small and trifling, I focus less on the utopic, literary manifestations of English microphilia and more on its application in the practical realm of metalworking. The sea-coal-like stone, by signifying domestic networks of manufacturing and distribution between the northern cities of England and London, circumscribes the English New World experience within the familiar context of English domestic industry and industriousness.

This chapter charts various expressions of this metallic skill in the prospecting voyages of Frobisher, Walter Raleigh, and John Smith. In all three voyages, the ore speaks to the men's qualities in spite of its unidentified status. The popular mythology surrounding Frobisher's "chance" finding of the black stone on his first voyage sets the tone for the subsequent voyages of Frobisher, Raleigh, and Smith by acknowledging the necessity of refining technologies even in the event of Godly miracles. A series of letters exchanged between Michael Lok and the Privy Council, in turn, underscores the centrality of the assay to those voyages; yet, given the controversy surrounding the results of the various assays on Frobisher's ore, actual results are supplanted by Lok's assessments of the perceived character and honesty of the assayers themselves. Similarly, Raleigh struggled to define metallic skill and took advantage of the undefined status of the ore supposedly found on his voyage to Guiana to sculpt his own identity. Smith, on the other hand, was more skeptical of the benefits of metallurgical projects given his practical bent. Yet he still believed that metallurgy conducted by skilled men of good judgment would yield fruit, and in fact, metaphorically deploys the language of the metallic arts to promote other industries, infusing such language with the skill and judgment possessed by its true practitioners. Texts from all three voyages reveal that England's lack of a reliable source of New World precious metals—the fruits and testaments of the Spanish empire's exploits in the New World—forced the English creatively to spell out their use of technologies that would yield them metals. In the process of recounting their actions in massaging metal out of the stubbornly resilient New World ores, English New World explorers assayed a narrative of metallic skill that attested to the high character and efficacy of the English.

In Best's narrative of Frobisher's second voyage to Baffin Island, which recounts Frobisher's failure to find gold, the black stone transforms from an anonymous "token" into a "greate miracle of God."³ The fact that only "*one* rich stone in all the iland" (emphasis mine) contained gold signifies for Best not a general lack of metals, but "God's divine will and pleasure" that England will increase its wealth "with no lesse abundance of His hyden treasures and golde mynes than any other nation."⁴ While on the one hand, the various renditions of the chance discovery of Frobisher's black stone figure the English as innocent recipients of God's grace, on the other hand, each version of the discovery incorporates instances of refining that span loci as diverse as the household and the workshop, reiterating the breadth of the English culture of metals described in chapter one. By implicating refining technologies in English New World discovery, these early versions of Frobisher's first voyage begin to articulate a specifically English form of discovery distinct from that of the Spanish that implies that the English, unlike the Spanish, need to work for their miracles, a point that speaks to their diligence and industry.

Whereas the early mythology of Frobisher's black stone describes the finding of that stone in accidental terms, the discovery of gold in the stone depends on the well-timed assaying or cooking of it, the domestic corollaries to the smelting of metals in a workshop. Best describes the discovery of gold on the first voyage as a serendipitous event in which one of the crew's wives, "fortuned" to have a "peece" of the ore which she "by chance [. . .] threw and burned in the fire, so long, that [. . .] it glistered with a bright Marquesset of golde."⁵ Richard Eden, in his translation of Peter the Martyr's

Decades of the New World, recounts a “straunge thyng,” when an old washerwoman “chaunced at the length by her good fortune to espie on the stone, a veyne of golde.”⁶ Other versions of this chance finding abound, including one in 1577 by Philip Sidney, who in a letter to his mentor describes Frobisher’s black stone as a “piece of earth” that “by chance a young man, one of the ships company, picked up. . . and kept. . . till his return to London. And there when one of his friends perceived it shining in an extraordinary manner, he made an assay.”⁷ Holinshed’s *Chronicles* documents “a piece of black stone, much like to a seacoal in color, which being brought to certain goldfiners in London, to make a say thereof, found it to hold gold, and that very richly for the quantity.”⁸ In all the versions of Frobisher’s discovery, the “chance” finding of gold requires both the presence of God’s grace and the accidentally applied skill of assaying ore.

These stories, in imagining the “chance” assaying of Frobisher’s ore, corroborate the English sense of discovery, which referred to an experiential reconnoitering rather than the visual uncovering typically associated with the Spanish sense of the word.⁹ In spite of their belated entry into the world of exploration, the English initially had hoped to replicate Spain’s luck. But, unlike the Spanish, who discovered gold and silver in Mexico and Peru that did not need to be further refined by artificial means because it existed in a relatively pure or “native” form, and the Portuguese, who found equal success in West Africa and Brazil, the English found in the New World only base metals in need of refining.¹⁰ Only later in the seventeenth century do even the Spanish realize the importance of refining technologies. In his *Art of Metals*, Alvaro Alonso Barba laments that the excesses of the Spanish empire have prevented it from developing a

domestic knowledge of refining: “This glut of Riches, hath been the reason why they have not applied the care that was requisite, to prevent loss and waste in the Refining of Oar.”¹¹

While the English did not have the luxury of lamenting a “glut of Riches,” their possession of mostly base metals prepared them to exercise their limited skills in metallurgy in the New World.

The English New World mineral experience mirrored the domestic attempts at colonizing mines in the Irish extremities of the realm. William Humphrey, Assay Master of the Royal Mint from 1565 and head of the Royal Mineral and Battery works, emphasizes the necessity of refining metallic ore when he attempts to persuade Queen Elizabeth to grant him the management of an Irish mine on account of his refining skills: “For the world is full of discoverers but it rarely brings forth recoverers; without the which all rich mines discovered are but poor.”¹² That skill in recovering metal from ore is what determines the distinction between rich and poor mines emerged from a dispute between Queen Elizabeth and the Earl of Northumberland over the possession of gold-rich mine. The Society of the Mines Royal instituted as a result of that dispute decreed every mine a royal mine unless it could be proven that the expenditure for the refining of the ore would exceed the actual value of the ore mined.¹³ Private landowners therefore benefited from employing metallurgical experts to maintain ownership over their mineral-bearing lands; the English Crown, in turn, benefited from funding the assaying of ores since any mine, however poor, potentially could contain precious metals. If the land of England simply had yielded veins of gold and silver, then the definition between a poor or royal mine would not have been so dependent on metallic skill.

The distinctions between English and Spanish New World ore made obvious by Frobisher's finding of the nameless and worthless black stone both foretold the future and mirrored the domestic state of English interactions with metallic ore. While the popular imaginings of Frobisher's initial discovery gestured toward the Spanish model of spontaneous discovery of gold, their inclusion of cooking and assaying—technologies analogous to one another in their reliance on the heat of a furnace—underscores the base reality of English mineral claims. Frobisher's first voyage, the counterexample of Spanish mineral riches, and other moments early in Elizabethan mining history set the stage for later appropriations of assaying technology in the service of an English model of character.

While the English never did find the precious metal resources they sought in the New World, they made sure to document the navigational and metallurgical processes they undertook in writings such as Richard Hakluyt's *Principall Navigations*, which Richard Helgerson has argued, compensated for England's inactivity relative to Spain and Portugal by creating a narrative of England's action in the world.¹⁴ As the above versions of Frobisher's discovery of the black stone reveal, Best's narrative treats the assay as a supplemental figure to that "chance" finding. Detailed descriptions of assays occur behind the scenes in correspondence between Michael Lok, the chief administrator of the voyages and Queen Elizabeth's Privy Council. Because the first voyage promised much gold ore on Baffin Island, the subsequent voyages, and the assays conducted on ore found on those voyages, required the utmost secrecy. To provide transparency to the Queen and other aristocratic investors such as the Sidney family, Lok described the

assays and the assayers who conducted them. In spite of the requirements of secrecy, he comes to define those who are social and open to collaboration as more skilled at assaying than those who are more guarded. Lok's efforts to transmit the activities of the assayers he oversaw had the unexpected effect of associating a person's character with his skill in administering the assay, a relation that continues to play itself out in subsequent English voyages to the New World.

During the course of Frobisher's three voyages, skill in metal refining took on national significance because England's interest in Frobisher's voyages stemmed from the desire to chart a route to China to mine gold. Frobisher's voyages received significant support, according to Robert Baldwin, because of a misplaced confidence in recent navigation and mining technologies.¹⁵ The investment in technology is all the more striking considering the common belief that gold was found not in the Arctic, but "between the two Tropikes under and Equinoctial or burning lyne, where the sunne is at greatest force."¹⁶ After the purported success of the first voyage (on which the black stone was found), Elizabeth decided to subscribe to the Northwest enterprise. Because of her direct participation, the Cathay enterprise was no longer a company, but became an agent for carrying out royal imperative, with all authority residing in the Queen.¹⁷

In order to ensure the success of the expedition, Elizabeth created a Commission on May 17, 1577, comprised of "gentlemen of great judgment, art, and skill."¹⁸ The duties of these skilled gentlemen entailed the "true trial and due examination" of both the Northwest Passage and the gold ore found there. In the "Instructions Given to Martyne Ffurbisher," the miners on Frobisher's voyage, whose identities are not known, and the London goldsmiths and assayers involved in the enterprise are advised to "not dyscover

the secreats of the riches of suche moynes as by you shall be founde out” to anyone except themselves and “such others as to you shall be thought fit should be made acquaynted therewith for her Majestie better service in that behalf.”¹⁹ This requirement of secrecy was a measure taken to curb the actions of the Spanish diplomat and spy Don Bernadino de Mendoza, who had sent reports of the voyages, ore samples, and a map of Meta Incognita to King Philip II.²⁰ Because of Mendoza’s actions, Elizabeth ordered the Commission to maintain secrecy about any ore mined on Baffin Island and any assay results concerning the ore. Those on the Commission, particularly those with metallurgical knowledge, essentially became technical informants. The metallurgical workers involved in Frobisher’s voyages to the Northwest Passage therefore implicated both their own identities and the identity of the English nation in the trials they conducted.

In order to offset the uncertainty of ever finding the Northwest Passage and valuable ore, Michael Lok, the administrator of the Frobisher enterprise and the liaison between the assayers and the Privy Council, described all of the assays in detailed letters addressed to Sir Francis Walsingham, Privy Counselor to Elizabeth and Secretary of State. By couching the knowledge about the metallic ores in terms of who handled the ores, Lok’s letters to the Privy Council create a model of skilled English action in the New World. Skilled metalworkers conducted a total of fourteen trials on the ore collected from Frobisher’s three voyages over the period of 1576-1581.²¹ The first, second and sixth assays, or “great proofs,” as Lok called them, were conducted by Jonas Schutz, the Assaymaster of the Mint and chief partner of William Humphrey in the Royal Mineral and Battery Works, at the furnace constructed in the Tower Hill garden of William

Wynter, a Bristol merchant who invested in the enterprise.²² These proofs were more important than the other ones because they were large-scale endeavors that determined whether subsequent voyages would be made.²³ John-Baptista Agnello, an Italian goldsmith living in England, and others undertook small-scale assays in 1577, the success of which led to large-scale furnace assays between November 1, 1577 and March 1579. Before conducting the large-scale assays, however, Lok had to produce a “grayne of gold” for Queen Elizabeth—physical proof that the ore warranted further refining. To this end, Lok documented his correspondence with a number of metallurgists in letters to Walsingham. The participating metallurgists included Jonas Schutz, Burchard Kranich (commonly known as Dr. Burcott, a famous German metallurgist and physician who, prior to the voyages worked lead ores in Derbyshire and silver ores in Cornwall), Agnello, and Robert, who acted as an assistant. William Williams (the Assaymaster of the Mint after William Humphrey, Senior) performed a final small double assay on July 8, 1583, in which no gold was found.²⁴ This final assay confirmed the fear that none of the ore found on Baffin Island actually contained gold.

Whereas Best’s narrative glosses over the detailed exchanges between Lok and the assayers, Lok creates a vivid picture of the high stakes involved in proving the ore to contain valuable metal. Lok recounts that Frobisher himself handed him a “stone aboard his ship,” stating that Frobisher promised that the ore was “the first thing that he founde [in the new l]and” (brackets editor’s).²⁵ To stress that he and Frobisher were not conducting secret transactions, Lok states that he received the ore “openly in the presence of two [other] men” (brackets editor’s).²⁶ Lok then mentions that he was not alone in taking a piece of the ore; others aboard the ship also took a “pece” of the ore “which they

caryed away with them.”²⁷ Lok then recounts that he gave the ore to a number of people to assay its content: Mr. Williams, the assaymaster of the Tower, Wheler, a refiner, and George Needham, another metal expert, all report that they “colde fynde no mettall therein” because the ore was “but a marquesite stone.”²⁸ Only when Lok goes to John-Baptista Agnello, does he begin to get results. He writes that he “delivered a small pece” to him “not telling what nor from whence” he got it.²⁹ Within three days, he states that Agnello showed him “a very little powder of golde.” Agnello then agrees to conduct two more proofs of the ore “to make a better proof” and “to make anatomy” of the ore.³⁰ After showing Lok two more samples of gold “powder,” Agnello wins Lok’s trust. Lok expresses his disbelief to Agnello that three skilled metalworkers “could fynde no such thinge therein,” upon which Agnello answers, “*Bisogne sapere adulare la natura*,” or “One needs to know how to admire nature.”³¹ A few days later, Lok writes that Agnello sends a “grayne of gold” to him—the very “grayne” enclosed in his letter to the Privy Council and the Queen.³² Laying bare the interactions between the assayers and the worthless ore is an example of the way in which Lok used a potentially a negative situation to describe their skill and judgment.

Lok frames the discrepancy in results among the assayers as a function not of the ore’s contents but of their mutual jealousies. Rivalries among Frobisher’s experts arose over competition for an exclusive contract to assay and refine all the ore associated with Frobisher’s voyages. He explains to Walsingham that the ore “is not brought to perfection” because the assayers “cannot yet agree togethers” and are “jelous of other to be put out of the work.”³³ Such dissension among the assayers had the benefit of allowing Lok to concede that, while the exact quantity of gold in the ore was debatable, the

presence of gold was not. Lok admits that despite their differences, “amongst them all we doo very playnlye see and fynd that the ure is very ryche, and the worst of all their doynge wyll yeld better than xl li. a ton, clere of charges.”³⁴ The dissension also buys Lok some time before he has to produce results. He promises that Walsingham will be “better certyffyed” of the gold “in a few dayes.”³⁵ Later he describes the “schisma” among the assayers as an impediment whose cause only “tyme must open.”³⁶ By describing sociability and cooperation among the workers as a condition conducive to the extraction of gold from the ore, Lok recasts his workers’ failure to find gold as their inability to get along with each other.

At odds with Elizabeth’s requirement of secrecy was Lok’s correlation between the assayers’ willingness to share knowledge and the quality of their assay results. He argues that their jealousies make them “lothe to shew their conynge or to use effectuall conferens,” suggesting that unsociability contributes to an atmosphere of secrecy.³⁷ Whereas secrecy was desirable where state secrets are concerned, it was undesirable among those working toward the common goal of acquiring gold for royal coffers. Lok claims that by establishing a “better lykynge” among the workmasters, he will be able to extract a “better matter” from the ore.³⁸ The sociability of each member of the Commission—the willingness of each expert to collaborate and “discover” the results of his assays to other experts—speaks to his fitness to “discover” the contents of the entire load of unidentified ore that Frobisher brought back from his first and second voyages. While secrecy was necessary given the delicate nature of the voyage, too much secrecy and competition among the assayers was, according to Lok, not beneficial to the royal cause.

Within these exchanges, the criterion of openness comes to define the ideal assayer. Maintaining openness in collaboration among the Commission members implied that nothing of personal value was at stake, whereas maintaining secrecy within the ranks of the company implied fraud. In a letter written to Walsingham to distinguish Jonas' qualifications to be the official assayer of the voyage over Kranich's, both Agnello and Jonas invoke openness as a criterion of good skill:

All the doings of Jonas from the tyme too tyme was donn openly, and Mr. Furbusher caryed all the secrets thereof too Mr. Burcott, too healpe him, and all Mr. Burcott doings was in secrett, soo as none knoweth yt but him selfe.³⁹

Although both Jonas and Kranich produce "secrets," their fitness to conduct assays depends on the delivery of those secrets to others. Jonas' "doings" are "donn openly," suggesting that they are done publicly and honestly. Furthermore, Frobisher's delivery of those results to Kranich (here referred to as Mr. Burcott), shows that Jonas, in the spirit of collaboration, is willing to share his secrets. Lok cites Jonas' willingness to engage in "conferens" as consistent with his reputation for being "honest and trew in his doinges."⁴⁰ In contrast, Kranich's "doings" are "in secret," suggesting his results are not reliable. According to Lok, Jonas openly "dislyked the dealinges of Mr. Burcott boethe for his evell manners and ignorance in diuers points of the woorks and handelynge of the ewer." Lok cites Kranich's excessive proofs (Jonas conducted only six proofs of the ore, as opposed to Kranich's forty proofs) as evidence that Kranich "was more ignorant than Jonas, in the knowledge of the nature and workinge of this ewer." Yet, Kranich's main failing, according to Lok, was that he "did cleave still too Jonas dooings and made little accompt of his doings," all the while making "great styre of his owne cunninge."⁴¹ For

Kranich to provide evidence of his “cunninge,” he would have had to relate to the other assayers his “doings” rather than keep them to himself. The link that Lok establishes between the social nature of knowledge exchange and good assay results suggests that a sociable person would be more likely to have successful assays than an unsociable one.

The distinctions that Lok creates between Kranich and Jonas’s skill in assaying depend on the degree to which they are willing to share knowledge with their fellow assayers. That these assays were conducted under the cloak of state security underscores why Lok would have emphasized the assayers’ characters as markers of their skill. The political intrigue surrounding Frobisher’s assayers continues into the seventeenth century. Frobisher’s voyages set the stage for later exploration in which the assay migrates from private correspondence to the travel narrative. Whereas character signifies assaying skill in Lok’s letters, in the subsequent narratives of Raleigh and Smith, the assaying of base metals comes to signify judgment and character.

The metallurgical processes that formed the stuff of secret commissions in Frobisher’s voyages migrate into the very public arena of the published narratives that served to document and promote the colonial ventures of Raleigh and Smith. Raleigh, intent on both restoring his former favored status with the Queen (whom he had angered by marrying one of her women-in-waiting, Elizabeth Throckmorton) and clearing himself of the charge that the ore he brought back from his voyage to Guiana was fool’s gold, identifies his own metallurgical skill with his honesty and forthrightness. Smith, intent on developing industries more certain than mining in Virginia, begrudgingly accepts the

good prospects of Virginian mining provided that people with the appropriate skill and judgment test the ores in question. Smith's ascription of judgment and wisdom to people with metallurgical skill, in turn, widens the signifying power of mining and metallurgical language; such technical language comes to refer not simply to the processes they describe, but to the judgment and character required for establishing the English colonies in Virginia. Whereas with Lok, good character implied skill in assaying, with Raleigh and Smith, the same metallurgical talents suggested the assayer's good character and judgment.

In his *Discoverie of Guiana* (1596), Sir Walter Raleigh responds to accusations that the ore he brought back from his 1595 expedition to Guiana was of apocryphal origins by appealing to his metallurgical expertise.⁴² Conducted after his many expeditions into Virginia under the patent previously issued to his half-brother Humphrey Gilbert, Raleigh's voyage to Guiana marked one of his many failed attempts to start a permanent English mining colony in the Americas. Trying to counteract the "divers opinions conceived of the gold oare brought from Guiana,"⁴³ Raleigh attempts to restore the luster of his reputation by distinguishing between those with metallurgical knowledge and those without it. Such distinctions in knowledge, as Mary Fuller has argued, typify Raleigh's attempt to justify the expenditure and ostensible failure of his 1595 expedition to Guiana by giving precedence to proof over profit.⁴⁴ Raleigh proves his own honor through metallurgical skill when recounting that, upon ordering his men to collect and test ore samples for gold, they stubbornly insisted that the ore contained gold despite Raleigh's best efforts to persuade them otherwise: "notwithstanding divers, trusting more to their owne sence, then to my opinion, kept of the said Marcasite, and have tried thereof

since my return in divers places.”⁴⁵ Raleigh’s assurance to the men of the stone’s low value argues his superiority to them. Blaming his men’s attraction to the showy and false appearance of Marcasite on their lack of judgment or experience, Raleigh suggests that in presenting the Marcasite as representative of all the samples of ore from his voyage, his company wrongly had “bred an opinion that all the rest is of the same.”⁴⁶ Raleigh points out that his company only came to their conclusions about the ore after having “delivered of those stones to be tried in many places.”⁴⁷ To respond to the results of their trials, Raleigh asks someone more authoritative, a Spaniard familiar to the area, to assay “some of these stones” which his company had “found loose on the ground.”⁴⁸ The Spaniard confirms that, while the stones themselves contain no gold, they signify the presence of a mine.⁴⁹ By distinguishing his specialized knowledge of metals from the company’s utter lack of knowledge, Raleigh implies that those who accused him of fraud, like his company, were easily persuaded by the gold-like attributes of marcasite because of their lack of judgment.

Raleigh explicitly calls upon skilled knowledge when he contextualizes the trials of metals retrieved by his captain from a Guianan mine within a professional network of London metalworkers: a refiner, an assay-master, the controller of the Mint, and a goldsmith.⁵⁰ Raleigh associates himself with those practitioners within his narrative by pointing out his knowledge of the instruments needed for metallic trials. The appearance of an Indian refiner’s basket assures the Queen that gold ore exists in Guiana: “I sawe an Indian basket hidden, which was the refiners basket: for I found in it his quicksilver, saltpeter, and divers things for the triall of metals, and also the dust of such ore as he had refined, but in those canoas which escaped there was a good quantity of ore and gold.”⁵¹

In this instance, Raleigh's spying of metallurgical accoutrements signifies the object in question—gold ore. By aligning his own specialized knowledge with that of the metal dealers, Raleigh attempts to substantiate his claims for the existence of Guianan gold. His invocation of the metallurgical assays on ore, in turn, represents his attempt to refashion himself as a reliable servant to the Queen.

Although the uncertain location of the mine sighted by Raleigh's captain cost both Raleigh and his captain their lives after the second Guianan voyage in 1617,⁵² the uncertainty of English New World mines eventually provided an opportunity to display English work and skill. While the very land of Virginia provided signs of metals, mere signs would not convince everybody; instead, detailing the work involved in recovering metallic ore ensured that the metal itself would be the focus of the narrative. Robert Johnson's *Nova Britannia* (1609) describes hills in Virginia that look as if they contain precious metals, provided someone searched them: "there are hills and mountains making a sensible proffer of hidden treasure, never yet searched."⁵³ In his *History of Virginia*, John Smith describes the existence of copper as a "probabilitie," or likely occurrence, provided someone worked for it: "Onley of Copper we may doubt is wanting, but there is good probabilitie that both Copper and better Minerals are there to be had for their labour."⁵⁴ The English uncertainty regarding New World mines provided the backdrop against which the importance of metallic practitioners, the people who would search or work the mine in order to discover its contents, came into focus.

To mitigate the uncertainty of finding gold, Smith, like Raleigh, invoked the "judgment" of those skilled in the metallic arts of surveying, mining, refining, and assaying. Smith invoked the standard of "better judgment" as necessary to temper a

layperson's susceptibility to glittering marcasite. In his *Description of New England*, Smith draws a parallel between the New England coastline and the coast of the English mining town of Devonshire: "but the most part so resembleth the Coast of Devonshire, I thinke most of the cliffs would make such lime-stone: if they be not of these qualities, they are so like, they may deceiue a better iudgement then mine."⁵⁵ In his *Map of Virginia*, Smith describes a "gilded" piece of ground that has "glistering tinctures," commenting that "both the rocks and the earth are so splendent to behold, that better iudgements then ours might haue beene perswaded, they contained more then probabilities."⁵⁶ Sometimes, the land proved to be more certain a sign of the presence of metals underground than judgment because of a lack of "men of experience" and "good Refiners." Smith describes self-styled refiners who, erroneously thinking themselves to "haue skill this way," collect "moskered shining stones and spangles," hoping to boost their shaky reputations as refiners "by the meanes of that ore, if it proued as their arts and judgments expected." Then there are the "men of experience" who know how to recognize the difference between fool's gold and gold ore or "mine spare."⁵⁷ According to Smith, the uncertainty lies not in the potential for the land to yield precious metals, but in the ability of skilled workers to distinguish between the natural imitations of gold ore and the real thing.

With reservation, Smith acknowledges the value of the assay, or trial, the instrument used to confirm judgment, but only to the extent that it provides reasonable evidence of the presence of gold. In his *History of Virginia*, John Smith tempers the persuasiveness of a series of trials he conducted on various samples of Virginian ore by hesitating to promise the certainty of his results, a trait typical of the early modern literary

stereotype of the alchemist: “I made many trialls according to the instructions I had, which doth perswade me I need not despaire but that there are metals in the Country: but I am no Alcumist, nor will promise more then I know.”⁵⁸ Smith’s distancing of himself from alchemy does not reveal his dislike of alchemy, which shared techniques with metallurgy; rather, he cautiously mitigates the purported efficacy of his own skill to limit the “gold fever” that was captivating his captain and company. The captain of his ship actively sought gold ore and conducted trials in Smith’s absence. Smith disapproved of these trials because he did not find them persuasive enough to justify neglecting the “necessarie business” of harvesting fish and cedar wood. He demanded the captain to “shew him a more substantiall triall,” irritated that the men spent valuable time to exercise their “durtie skill” on “so much gilded durt.”⁵⁹ By invoking “better iudgement,” Smith, like Raleigh, aligns himself with those who know, safeguarding himself from being accused of mistaking “glistering” rocks of “durt” for real gold.

Smith’s caution in overvaluing the assay was motivated by his desire to place his bets on commodities more profitable than precious metals; but his attempts to win investors over to these more certain resources are couched in terms of the very industries he seeks to avoid: mining and metallurgy. In his *Description of New England* (1616), Smith gestures toward fish and furs as a possible alternative in the event that the search for gold in New England fails: “our plot was there to take Whales and make tryalls of a Myne of Gold and Copper. If those failed, Fish and Furies was then our refuge, to make our selues sauers howsoever.”⁶⁰ In his *Historie of Virginia*, Smith tries to convince the English that fishing “will afford as good gold as the Mines of Guiana or Potassie, with lesse hazard and charge, and more certainty and facility.”⁶¹ Smith contrasts the short-term

economic success of the Spaniard, who “with all his Mynes of golde and Siluer,” failed to “pay his debts, his friends, & army,” with the “Hollanders,” who, having made the “contemptible trade of fish” “their Myne,” have outdone the Spanish by making the sea “the source of those siluered streames of all their vertue.”⁶² Smith’s praise of the Dutch fishing industry disrupts the usual reverence given to the Spanish discovery of gold in the New World and attempts to attract the English to alternative commodities. Smith’s deployment of mining metaphors to persuade potential investors about the value of alternate Virginian natural resources has the unintended effect of investing the language of mining and metallurgy with the wisdom and industry he attributes to people such as the Dutch.

A series of dedicatory poems preceding Smith’s *History of Virginia* illustrates that mining and metallurgical language referred not simply to the literal practices of the metalworking fields, but to the widely applicable judgment and efficacy implied by those practices. These poems pun on Smith’s name by taking the metallurgical meaning of the word “smith” to speak for his ability to improve material conditions in Virginia. An anonymous supporter predicts that Smith’s “art and skill” in “smithing” Virginia will secure England’s place in the history of exploration by finding “golden Iasons fleece” and “Anvil[ing] out a peece/To after Ages.”⁶³ Among the skills he attributes to Smith are that he “hammered famins soyle” and “Vulcan like did forge a true Plantation.”⁶⁴ Samuel Purchas similarly lauds “Smith’s forge,” which “mends all” by making “chaines for the Savage Nation.”⁶⁵ Robert Norton concurs with Purchas, stating that Smith’s “Anvill was Experience,” which included the knowledge of “how and when to Strike.” Unlike “unskillfull workmen” who “can never Fyle/Nor Pollish it, that takes in Forge such

toyle,” Smith “shewest the Temper true” by working “well this Peece” and “tak[ing] his heat.”⁶⁶ According to his supporters, Smith is both metalworker and metal, both the agent and patient of the “Anvill” of experience, praise that transforms the metallic arts into emblems of efficacious action and good judgment.

Lauded for his “Vulcan like” “smithing” of Virginia into an agriculturally rich and spiritually saved region, Smith retains a connection to the earth that at first seems to give way to his interest in developing fish and timber as the primary Virginian exports. Whereas Raleigh invokes the mastery of metallurgy and mining to save his own skin and reputation, Smith focuses on developing colonial industries, with the skill and judgment implied by his eponymous epithet, “smith,” being an outgrowth of his frustration with his company’s obsession with gold rather than with the commodities that would benefit the English commonwealth in a practical way. Smith’s description of these commodities in terms of mines and his openness to searching for mines provided they are worked and tested by men of skill and judgment suggest that, like Raleigh, Smith imagines the definition of Englishness in the New World through the diligent processing of its less-than-perfect ores.

Lok, Smith and Raleigh’s reiterations of their efforts to find metals in the New World represent the English attempt to grapple with the encounter of mineral sameness suggested by base metals rather than the Spanish otherness represented by gold. By means of the chance encounters with the English geological macrocosm in the New World, English microcosmic identity is both mirrored in the base ores, sea-coal look-alikes, and “gilded durt” found in the New World and reiterated in the repeated attempts

to work those ores into something other than the self. The attempts to mold the self in service of the Crown indirectly through the matter of metals illustrate an instance of the early modern English mettle in action.

¹ Richard Collinson, *The Three Voyages of Martin Frobisher* (London: Hakluyt Society, 1867), 75. Published in the nineteenth century by the Hakluyt Society, this edited collection, which brings together George Best's three narratives of Frobisher's voyages to Baffin Island and a series of State Papers pertaining to technological and political issues for each trip, suggests that interest in specialized knowledge continued even until the nineteenth century. Although Best's account of the black ore is the most quoted among the various narratives of Frobisher's voyages, an account by Michael Lok, the treasurer of the Cathay enterprise, exists as well in manuscript in *The Doynges of Captayne Furbushur*, British Library, Landsdowne MS 1001, f. 2R, quoted in D. D. Hogarth, P.W. Boreham, and J.G. Mitchell, *Martin Frobisher's Northwest Venture, 1576-1581: Mines, Minerals, Metallurgy* (Hull, QC: Canadian Museum of Civilization, 1994), 30.

² Jeffrey Knapp, *An Empire Nowhere* (Berkeley: University of California Press, 1992), 59-60.

³ Best, 128.

⁴ Ibid.

⁵ Best, 75-6.

⁶ Pietro Martire d'Anghiera, trans. Richard Eden, *The Decades of the Newe Worlde* (London, 1555), 167.

⁷ S. Pears, *Correspondence of Sir Philip Sidney and Hubert Languet* (London: William Pickering, 1880), 118-19, 226, quoted in Hogarth et. al., 31-32.

⁸ 4:330, quoted in Knapp, 60.

⁹ The *Oxford English Dictionary* lists among the more conventional senses of discovery linked with vision an obscure sense that means to explore and investigate through reconnoitering or reconnaissance. "Discovery" for the English, as opposed to the Spanish and Portuguese sense of seeing and naming, depended less on having seen something than on having been somewhere. See Patricia Seed, *Ceremonies of Possession in Europe's Conquest of the New World 1492-1640* (New York: Cambridge University Press, 1995).

¹⁰ Although Henry VIII dabbled in the domestic mining of gold, silver, and copper, a full-fledged search for gold in the New World started only after Queen Elizabeth's institution of the Societies of the Mines Royal and of Mineral and Battery Works in 1568. James A. Mulholland, *A History of Metals in Colonial America* (University, AL: University of Alabama Press, 1981), 7, 10-11.

¹¹ Alvaro Alonso Barba, *The Second Book of the Art of Mettals, wherein is Taught the Common Way of Refining Silver by Quicksilver with Some New Rules added for better performances of the same* (London, 1674), 2

¹² See M.B. Donald, *Elizabethan Monopolies*, (Edinburgh: Oliver and Boyd, 1961), 12.

¹³ For an overview of this dispute, see *ibid.* Also see Eric H. Ash's *Power, Knowledge, and Expertise in Elizabethan England* (Baltimore, MD: Johns Hopkins University Press,

2004) for a discussion of this dispute in the context of the rise of English expertise. On the history of English mining policy, see John Pettus, *Fodinae Regales, or the History, Laws and Places of the Chief Mines and Mineral Works in England, Wales, and the English Pale in Ireland* (London, 1670).

¹⁴ Richard Helgerson, *Forms of Nationhood: The Elizabethan Writing of England* (Chicago: University of Chicago Press, 1992), 176.

¹⁵ Robert Baldwin, "Speculative Ambitions and the Reputations of Frobisher's Metallurgists" in *Meta Incognita: A Discourse of Discovery*, ed., Thomas H.B. Symons (Hull, QE: Canadian Museum of Civilization, 1999), 413.

¹⁶ Richard Eden, *A Treatyse of the Newe India* (London, 1553).

¹⁷ James McDermott, "The Company of Cathay," 147-87 in ed., Symons, 158.

¹⁸ Collinson.

¹⁹ Collinson.

²⁰ Bernard Allaire and Donald Hogarth, "Martin Frobisher, the Spaniards and a Sixteenth-Century Northern Spy," 575-88 in ed., Symons, 19, 21.

²¹ For studies interested in whether the assays produced accurate results, see Table 5 in Hogarth et. al., 74-5 and Bernard Allaire, "Methods of Assaying Ore and their Application in the Frobisher Ventures," 477-504 in ed. Symon.

²² Hogarth et. al.

²³ Robert Baldwin, "Speculative Ambitions."

²⁴ Ibid.

²⁵ "Mr. Lockes Discoors Touching the Ewre, 1577," in ed., Collinson, 92.

²⁶ Ibid.

²⁷ Ibid.

²⁸ Ibid.

²⁹ Ibid.

³⁰ Ibid., 93.

³¹ Ibid.

³² Ibid.

³³ Michael Lok to Sir Francis Walsingham, London, 23 November 1577, ed., Collinson, 192.

³⁴ Ibid.

³⁵ Ibid.

³⁶ Lok to Walsingham, London, 30 November 1577, ed., Collinson, 195.

³⁷ Lok to Walsingham, London, 23 November 1577, ed., Collinson, 192.

³⁸ Ibid.

³⁹ "A Little Bundle of the Tryeing of the Northwest Ewre," in ed. Collinson, 177.

⁴⁰ William Wynter and Lok to Walsingham, London, 6 December 1577, ed., Collinson, 197.

⁴¹ Ibid.

⁴² Stephen Greenblatt, *Sir Walter Raleigh: The Renaissance Man and His Roles* (New Haven: Yale University Press, 1973), 103.

⁴³ Walter Raleigh, *Discoverie of Guiana* (London, 1596), 343.

⁴⁴ Mary Fuller, "Raleigh's Fugitive Gold: Reference and Deferral in *The Discoverie of Guiana*," in *New World Encounters*, ed. Stephen Greenblatt, 218-40 (Berkeley:

University of California Press, 1993), 206. See also, William West, "Gold on Credit: Martin Frobisher's and Walter Raleigh's Economies of Evidence," *Criticism* (1997).

⁴⁵ Raleigh, 344.

⁴⁶ Ibid., 404.

⁴⁷ Ibid., 344.

⁴⁸ Ibid., 404.

⁴⁹ Ibid.

⁵⁰ Raleigh, 344.

⁵¹ Ibid., 389.

⁵² Greenblatt, *Raleigh*, 164.

⁵³ Robert Johnson, *Nova Britannia. Offering Most Excellent fruites by planting in Virginia* (London, 1609), sig. C1^r.

⁵⁴ John Smith, *The Generall Historie of Virginia, New-England, and the Summer Isles* (London, 1624), 29.

⁵⁵ Ibid., *A Description of New England* (London, 1616).

⁵⁶ Ibid., *A Map of Virginia with a Description of the Covntrey, the Commodities, People, Government, and Religion* (London, 1618), 3.

⁵⁷ Ibid., 15.

⁵⁸ Ibid., *Generall Historie*, 213.

⁵⁹ Ibid., 137.

⁶⁰ Ibid., *Description of New England*.

⁶¹ Ibid., *Generall Historie*, 248.

⁶² Ibid., *Description New England*.

⁶³ Ibid., *Generall Historie*, sig. A1^r.

⁶⁴ Ibid.

⁶⁵ Ibid.

⁶⁶ Ibid., sig. A2^r.

Chapter Three
The “Tyrant Custom” of War:
The Construction of Military Mettle through the Metallic Arts in Shakespeare’s
Plays

*The tyrant custom, most grave senators
Hath made the flinty and steel [couch] of war
My thrice-driven bed of down. I do agnize¹
A natural and prompt alacrity
I find in hardness; and do undertake
This present wars against the Ottomites.
Othello, Othello, 1.3.229-233²*

This moment in Shakespeare’s *Othello*, when Othello assures the powers of Venice that his recent elopement with Desdemona will not inhibit his ability to lead the Venetian naval fleet against the Turkish “Ottomities,” illuminates the centrality of what Othello calls “tyrant custom” to the cultivation of military fitness in the early modern period and the virtue of courage, the commonplace understanding of what “mettle” constitutes.³ While Othello does not invoke explicitly the virtue of “mettle,” in the course of defining the “tyrant custom” of military action, he alludes to the hard, shiny, material counterpart to mettle: metal. His reference to the “flinty and *steel* [couch] of war” (italics mine)—one of many experiences of “hardness” to which an early modern professional soldier like Othello would be expected to “[ac]custom” himself and for which Othello believes himself to exhibit a “natural and “prompt alacrity”— illuminates a common conflation (both in the early modern period and in modern-day scholarship⁴) between metals and military courage. On the one hand, this conflation, which stems from a chivalric synecdoche between a soldier’s skin-like armor and his resolve to withstand the

blows of fortune,⁵ confirms what I have been arguing for throughout the dissertation, that an analog exists between metal and mettle. On the other hand, the commonplace association of metal with specifically military mettle fails to account for the intervening “custom” that produces that association, especially in the context of early modern warfare, which became increasingly reliant on artillery powered by gunpowder. The introduction of gunpowder in the theater of war and the stage to astonish enemies and spectators alike implicates a certain “know-how” in the production—both cultivated and natural—of mettle. This know-how is akin to Othello’s self-awareness, his “agnizing” of the way in which the “tyrant custom” and his own natural inclinations conspire to harden him to war.

In response to those critics who see the link between mettle and the military to be an innate hardness, I consider in this chapter the way in which rough military “custom” on the early modern stage was imagined to create military mettle. I define this “custom” as a primarily technological intervention that requires knowledge—something akin to Othello’s “agniz[ing]” of his own tendencies toward hardness. I argue that early modern military hardness is created through the technological intervention of the metallic arts, a point that prominently plays itself out on the early modern stage, which synecdochically depicts its “theatre” of courage through the sounds of military fanfare elicited by swords, armor, cannons, guns, and gunpowder—the loss of which harsh sounds Othello laments as he surrenders from his “occupation” (3.3.357). But in emphasizing the interaction of technology and military action, I am not subscribing to deterministic readings of technology in military history regarding the “military revolution,” which argue in Whiggish fashion that changes in military technology advanced Elizabethan military

strength.⁶ Rather, I argue that Shakespeare's plays describe military mettle in terms of the metallic knowledge necessary to create those hardened selves through both practice and theory.

The reference in the epigraph above to Othello's "natural and prompt alacrity" toward a sense of military "hardness" defined by its "flinty" and "steel" nature in many ways confirms the innate association between mettle and metal. The notion that military mettle is equivalent to metal relies on a chivalric model of military selfhood in which a soldier's innate, armor-like resistance to the blows of fortune defines his courage. A representative statement of this view occurs in *Troilus and Cressida*, when Agamemnon defends the seven years of stalemated war against the Trojans as "protractive trials" (1.3.20) sent from the gods to "find persistive constancy in men." But by insisting that war will "*find*" (1.3.21, italics mine) the "metal" (1.3.22) of "persistive constancy," Agamemnon relies on a model of discovery that presumes the innate and unchanging quality of the "metal" of "persistive constancy" despite the fact that according to his own rhetoric, a soldier endures a process of "trials" in order for that "metal" to be visible. Agamemnon further emphasizes the passive resistance of the soldier by saying that the "fineness" of "metal" "is not found/In fortune's love" (1.3.22-3), which willy-nilly dubs all types of men "affined and kin" (1.3.25), but in "the wind and tempest" of fortune's "frown" (1.3.26), which "winnows the light away" (1.3.28), leaving only that which "hath mass or matter" (1.3.29) and "lies rich in virtue and unmingled" (1.3.30). Disallowing the possibility that a soldier of any ilk could create his own massy mettle

through the “tyrant custom” of war, Agamemnon ascribes all agency in the discovery of mettle to the vagaries of fortune.

Agamemnon’s ascription of “mass” and “matter” to the triumphant soldier who survives the buffeting winds of fortune is in line with a common association in modern-day scholarship of military courage, or “mettle,” with “metal,” as the spelling in this excerpt from Shakespeare’s *Troilus and Cressida* illustrates. Emblematic of the scholarly conflation between the metallic and the military is the work of Gail Kern Paster, which, in tracing the material dimensions of the passions through the figures of Pyrrhus in *Hamlet* and *Othello*, attributes the metal/mettle analogy to the analogy between the flesh and the earth.⁷ Intent on illustrating the way in which the early modern theory of complexions connected interior emotion to the exterior world, Paster reads Pyrrhus’ warlike appearance, “roasted in wrath and fire” (2.2.461), as “reif[ying] his black purpose” to destroy Troy.⁸ Paster describes this internal purpose as having “its own hard consistency, its own texture, as if wrathful flesh were the armor of disposition.”⁹ Paster’s warrant for reading mettle/metal as a manifestation of the connection between flesh and earth is found in Leonard Barkan’s history of the Renaissance notion that humans are microcosms of the world.¹⁰ Paster’s invocation of the “rei[fication]” of Pyrrhus’ “black purpose,” insofar as it implies the “thingification” of an abstract, internal, and more primary “purpose,” calls upon the distinctly Platonic variant of the notion of the microcosm, which Barkan describes as a “physical wholeness which may contain shadows of all the ultimate realities.”¹¹ The Platonic sense of microcosm naturalizes and elides or erases the technological interface necessary to know of the metals that figure in that commonplace resemblance. In the case of mettle/metal, simply knowing the

subterranean, earthly correspondent to one's mettle, or will to act, requires the intervention of the metallic arts.

In the interests of unfolding the process (something akin to Othello's recognizing or "agniz[ing]" his own hard disposition to the "tyrant custom" of war) whereby courageous selves become as hard as metal, I turn to what Barkan describes as the Aristotelian notion of the microcosm between the flesh and the earth: an "epistemological microcosm" that entails "man's active participation" in knowing the natural world analogous to him or herself.¹² The Aristotelian sense of the "epistemological microcosm" would lay bare the technical process whereby "black purposes" are reified into the bloody "armor of disposition." To some extent, Paster's environmental approach approximates a technological one in that all technologies are essentially ecological, that is, they require mutually reinforcing interactions between two entities. For instance, Pyrrhus takes on the attributes of the warlike environment that he has created, which is, in turn, expressed in the heraldic colors of black, red, and white that decorate his shield.¹³ But in describing the rhetorical effect of this mirroring between inside and outside as a form of *transumption*, which Paster defines as "a rhetorical figure that designated both the actual transfer of qualities from one place to another and the metaphorical transfer of terms,"¹⁴ Paster elides the causal mechanism whereby that transfer occurs. According to Richard Lanham, the figure of transumption refers to a metaphoric relation that actually masks a remote causal relation between the first and second terms.¹⁵ The relation only appears to be analogical because of the collapsing of intermediate causalities. Her invocation of rhetorical figure of *transumption* implies a transfer of qualities between interior and exterior that elides the remote causal relations between Pyrrhus "black purpose" and the

“hard environment”—a relation that Othello acknowledges through his invocation of the “tyrant custom.”

One moment in the visiting player’s recitation of Aeneas’ tale to Dido that Paster glosses over suggests that the means of making weapons are instructive for describing their efficacy as agents of military purpose. An instant after “Pyrrhus’ pause” (2.2.487) in killing Priam, a “roused vengeance sets him new a-work” (2.2.488) with the intensity and surety of “the Cyclops’ hammers fall[ing]/On Mars’s armor forg’d for proof eterne” (2.2.489-90). As the assistant to Vulcan, the classical god of the forge, Cyclops represents the brute force behind the more intricate engineering and fashioning for which Vulcan is known.¹⁶ The Cyclops’ “fall[ing]” hammer represents the way in which Pyrrhus’ affect turns into lasting and efficacious action, while pointing out to Hamlet, the auditor of this piece, his own inefficacious muddled mettle. This positive literary reference to Vulcan and his helper contrasts with commonplace literary imaginings of alchemy, in which Vulcan represents the originator of all that is absurdly overwrought. A vivid example of this is Ben Jonson’s 1615 masque, *Mercury Vindicated at the Alchemist’s Court*, in which Vulcan’s work is described as “more/imperfect than the very flies and insects that are [Nature’s] trespasses and/‘scapes.”¹⁷ In the context of Pyrrhus’ story, however, the mention of the Vulcanian space of the metallurgical laboratory is symptomatic of a broader cultural and literary investment in the technical labor of war.

According to Nick de Somogyi, the shift in military technology from swords, longbows and cavalries to artillery, infantries, and siege battles increased the reliance on gunpowder during battle, a trend that “reanimated the classical mythology [... of] Vulcan’s smithy.”¹⁸ While Somogyi contextualizes the resurgence of Vulcan and his

one-eyed assistant within the wider Ovidian discourse of the Iron Age (which was believed to have founded warfare and cut short the idyllic Golden Age with the mining of iron and saltpeter for the production of artillery and armaments¹⁹), such an approach underestimates the extent to which the metallic arts were invoked in positive ways to describe a technological impetus to action. As illustrated through the example of Pyrrhus' sword, the mythology of Vulcan reinvests the elite discourse of swords and heavy armor with the artisanal work necessary to create them. The resurgence of the myth of Vulcan, in turn, reinforces the "workmanlike spirit" of English cast-iron armaments, which, compared to Continental cannon and armaments, which were finely wrought in brass, armaments, were very difficult to work finely.²⁰ Othello, for instance, describes his "sword of Spain" in terms of its means of production, calling attention to its being strengthened by cold water in an "ice brook's temper" (5.2.253). In *Troilus and Cressida*, Hector, like Pyrrhus, expresses his superlative resolve to kill Achilles "every where, yea, o'er and o'er" (4.5.256) by swearing "by the forge that [stithied] Mars his helm" (4.5.255, brackets editor's). Similarly, Troilus describes the intensity of his jealousy for Diomed by resolving that his "sword should bite" (5.2.176) Diomed's "helm" (5.2.174) "were it a casque compos'd by Vulcan's skill" (5.2.175). What galvanizes the "youth of England" (2.0.1) in *Henry 5* are the efforts of the "armourers," who in turn "thrive" off the prevalence of "honours' thought" (2.0.3). On the eve of battle, those same armourers "give dreadful note of preparation" (4.0.14) by "accomplishing the knights/With busy hammers closing rivets up" (4.0.12-3). These references to the metallurgical work behind a decidedly chivalric and elitist martial culture of armor and swords speak to a cultural shift in the early modern understanding of the nature of military exploits.

The brunt of that shift entailed the supplanting of edged weapons (and the chivalric ideals they upheld) by ballistic weaponry, whose reliance on gunpowder, while deemed a cowardly escape from the honor of man-to-man combat by its opponents, upheld artisanal ideals of workmanship, know-how, and good soldiering.²¹ Emblematic of this shift between edged and ballistic weaponry is Peter Whithorne's translation of Machiavelli's *Art of War*, which contains a section from Vannoccio Biringuccio's *Pyrotechnia* on the making and refining of gunpowder, artillery, and fireworks—despite Machiavelli's reservations about the ineffectiveness of artillery in the infantry-heavy warfare he promoted.²² For instance, Niccolo Tartaglia, the Italian ballistics expert whose *Three Bookes of Colloquies* circulated widely in England, regarded the “skilfull shooting in great and small peeces of artillerie” as crucial to successful battle.²³ Similarly, William Bourne claimed that “The Arte of Shooting in great Ordnance is necessarie to be advaunced for the defence and mainteynance of a Kingdome, and countrey, and the commonwealth thereof.”²⁴ Those who did not approve of guns, as Nina Taunton has explained, engaged in lengthy debates in print with gun-advocates during the early modern heyday of “military humanism.”²⁵ According to military historian Bert Hall, whose views can be construed as sympathetic to those of the early modern anti-gun camp, “edged weapons permitted a gratifying blend of moral purpose and economic benefit [...] a role that could not be readily imitated by any sort of missile weapon.”²⁶ Guns often were vilified not only because they killed indiscriminately, but because they eliminated the possibility of using prisoners as leverage. Hall's observations ring true as far as the relative inaccuracy of English shot and gunners in the field is concerned;²⁷ but Hall's assessment does not account for the role that the new knowledge of gunnery

played in sculpting a distinct sense of “moral purpose” modeled on the physical trajectory of exploding gunpowder.²⁸

In spite of the limited efficacy of ballistic weaponry on actual battlefields against enemies, guns were imagined in Shakespeare’s plays to be instrumental in turning one’s own men into warriors. Shakespeare’s plays deploy the imagery of ballistic weaponry to represent the vector-like movement of will toward matter. While Pyrrhus’ intentional smiting of Priam’s crown is an example of the intention embedded in the deployment of a sword, many moments in the plays come down on side of guns, both in terms of the thematic ascription of agency to bullet-like characters such as Hotspur and Fortinbras and in terms of stage practices. With the onset of ballistic weaponry, mettle becomes something that is quickly cultivated and just as soon extinguished, as in the example of Hotspur, upon whom Falstaff grants the epithet “gunpowder” (5.4.119) and whom Mortimer extols for using his “metal” (1.1.116) to momentarily “steel” (1.1.116) soldiers, who, upon Hotspur’s death, “turn’d on themselves, like dull and heavy lead” (1.1.118). The lofty rhetoric generals use to rile up their soldiers also follows a ballistic model of inciting action. For example, Brutus explains his confidence that his countrymen need no “spur but [their] own cause” (2.1.123) on the basis of their ability to “bear fire enough/To kindle cowards, and to steel with valor/The melting spirits of women” (2.1.120-22). To think otherwise, according to Brutus, would mean “stain[ing]” the “insuppressive mettle of [their] spirits” (2.1.132-33). Similarly, in *Henry 5*, King Henry’s instruction to his soldiers to let their eyes “pry through the portage of the head/Like the brass cannon” (3.1.10-11) transforms the troops from men into literal armaments like those dotting the actual coasts of sixteenth century England.

Reading this dramatic moment of transmutation from man into metal as a “violent muscular contortion” containing “all the sense of metallic echoing sound” that throughout *Henry 5* represents “the sensation of stupendous energies at work,” Michael Goldman points to the theater’s use of guns as stage properties—both practically and thematically—to signify the intentionality of action in general.²⁹ The Chorus extends this drive toward action to the audience, asking them to “Work, work your thoughts, and therein see a siege” (3.0.25), the endpoint of which is a “nimble gunner” (3.0.31) “touch[ing]” the “devilish cannon” with a piece of “linstock” (3.0.32). Several have interpreted such lines as indicating Shakespeare’s love of the sounds of war,³⁰ an argument not completely implausible given the inherent theatricality of cannons and gunpowder—as attested to by Italian ballistics expert Niccolo Tartaglia in his *Three Bookes of Colloquies* (1588), in which he claims that nothing can “astonish the eies, and eares of the profane hearted and the earthly minded enemies of Gods religion and our Princes peace than the lightening of gunpowder and the thundering Cannon.”³¹ Othello confirms the bewildering effects of the sounds of war when, at his wit’s end upon learning that he wrongly has accused Desdemona of adultery, he collapses the end of his military “occupation” (3.3.357)—his source of comfort—with the sounds of war meant both to embolden and terrorize its auditors: an ensemble of trumpets, drums, and fifes (3.3.351-2) and “mortal engines, whose rude throats/Th’immortal Jove’s dread clamors counterfeit” (3.3.355-6). That Othello invokes these metallic instruments of war as the end-all-be-all of his entire military career, the “tyrant custom” that hardened him into an experienced soldier, points to the imagined importance of weaponry in steeling troops into action.

The theatrical use of pyrotechnics to signify synecdochically wars that cannot be staged would seem to reify the commonplace conflation between military mettle and the metal without acknowledging the intervening “custom” of technology that allows that connection to occur. Even Tartaglia, who would seem to regard guns as mere props that “astonish the eies and eares” of enemies, ascribes the catalysis of soldiers not simply to the phenomenological effects of artillery, but to the knowledge and technology required to make and operate those weapons:

what can more encourage and strengthen souldiers [...] than artificiall making of saltpeter, gunpowder, mynes, and many sorts of fireworks? Than right use of al those and many other serviceable devises?³²

For Tartaglia, the theatricality of artillery is the product that soldiers deliver to enemies; soldiers themselves derives strength, courage, and mettle from the “artificiall making” and “right use” of the “fireworks” they use against others. Shakespeare recognizes the artisanal basis of stage effects meant, in the words of Tartaglia, to “astonish the eies and eares” of theatrical audiences. Using the language of mines and artillery to compare the craft of theater with warcraft, Shakespeare draws, in particular, upon the element of surprise in military stratagems gone awry. For example, in *Hamlet*, the clandestine detonation of gunpowder in underground mines figures in a metatheatrical reference to Hamlet’s counterplot against Claudius’ attempt to banish, and eventually murder, him:

Let it work,
For ‘tis the sport to have the enginer
Hoist with his own petar, an’t shall go hard ac
But I will delve one yard below their mines,
And blow them at the moon. O, ‘tis most sweet
When in one line two crafts directly meet.
(3.4.205-210)

By describing Claudius' and his respective plots in terms of the digging of mines and countermines, Hamlet implies that they both are engaged in a contest of military proportions. More telling, however, is his description of their mutual endeavors as "two crafts"—implying that both military tactic and the theatrical dissembling at Claudius' court draw upon artisanal ways of thinking.³³ Claudius, in turn, discusses his plot against Hamlet in similar terms before the duel between Laertes and Hamlet, emphasizing the need for them to "have a back or second" (4.7.153) "project" (4.7.152)—poisoning Hamlet's chalice—in the event that the current one—unfairly fighting Hamlet with a deadly, poison-dipped sabre—"blast[s] in proof" (4.7.154). Claudius' reference to cannon fire gone awry again draws upon the theatrical dimensions of gunpowder and its tendency to blow up in the face of its spectators when they least suspect it. Both Claudius' and Hamlet's attempts to outsmart each other rely on a working knowledge of gunnery that in turn galvanizes their attempts to accomplish their respective goals.

According to sixteenth-century military theorist John Sutcliffe, the surprise attacks that Hamlet and Claudius attempt to curtail with their knowledge of gunnery are significant not only for the tactical reality that "the enemy maketh least resistance [...] when he is most sodainly surprised," but for what they reveal about the mental condition of the soldier upon firing. A surprised enemy, for Sutcliffe, suggests that a weapon has been "profitably imploied with good judgment," without which deliberative skill armaments "serve for nothing, but to make a shew."³⁴ The notion that weapons deployed without judgment constitute mere spectacle suggests that a trigger-happy soldier does not a mettled man make. Rather, knowledge, judgment, and expertise in artillery steel soldiers' courage by making them feel prepared against being "sodainly surprised" by

an enemy. Moreover, the intervening faculty of judgment that Sutcliffe deems necessary for the operation of gunnery avoids automatically conflating metal and military mettle, instead providing some specificity about the nature of the military “custom” that steels soldiers in battle. The “tyrant custom,” therefore requires not only assuming the form of the weapons of war, as in the case of King Harry’s troops, but internalizing the means of making those weapons (be they edged or ballistic) and the most prudent method of deploying them both to astonish the enemy and to bolster one’s fellow troops, however momentarily.

The thematic and metatheatrical moments in *Hamlet* and other plays that depend on the theatrical dimension of ballistic weaponry provide an artisanal understanding of mettle/metal as expressed through swords, armor, and cannon, all of which were produced by the artillery camp, a diverse group of captains, engineers, artisans, and day laborers whose technical work implemented the orders of highly placed generals. Usually situated at the outer edges of the camp, the artillery camp, especially the unskilled laborers, or pioneers, responsible for digging mines and building bridges, had an ambivalent status. This uncertain status corresponded, according to Nina Taunton, to a microcosmic organization of the entire camp based on the Aristotelian universe. Such a setup imagined the general to be at the center and the lowest orders of the camp to be at the periphery.³⁵ Hamlet and Claudius’ invocation of a set of practices performed by low-ranking members of the military therefore introduces a sense of ambivalence in the hierarchy of the early modern military that the plays register by depicting varying, often contradictory, “custom[s]” for creating military mettle: theory and experience.

Interestingly, the drama's question over what constitutes a good soldier—a variation on the question of mettle—is explained not in terms of action, but in terms of the type of knowledge a soldier possesses.

An illustrative moment in the plays in which these contradictory methods of creating mettle converge occurs in *Troilus and Cressida*, when Ulysses reports that their troops “esteem no act/But that of hand” (1.3.199-200):

So that the ram that batters down the wall,
For the swinge and rudeness of his poise,
They place before his hand that made the engine,
Or those that with the fineness of their souls
By reason guide his execution.

(1.3.206-210)

Ulysses identifies two levels of military endeavor against which the general camp, which “esteem[s]” the brute force of the battering ram, has pitted itself: the engineers, whose “hand[s...] made the engine” and the generals, who, drawing upon their vast store of strategic knowledge, “by reason guide [the] execution” of the ram. Ulysses’ description reveals not only a line of military command that regulates and standardizes the collective action of an army, but the way in which military action is the result of a combination of brute force, technology, and reason. This moment is indicative of an anxiety in military writings that the lesser members of an army could take over on the basis of their operation of artillery and military engines—the sheer “swing and rudeness” of which was feared to imbue soldiers with a sense of agency and mettle.

Ulysses’ statements suggest that the views of the camp are the result of Agamemnon’s attempts to gild his inefficacy as a leader with regal-sounding military anachronisms (e.g. that the protracted stalemate against the Trojans is nothing more than a “trial” to “find persistive constancy in men”). Ulysses stresses the gravity of the

situation to Agamemnon and Nestor by informing them that the Greek soldiers have “neglected” the “specialty of rule” (1.3.77) warranted by the “degree, priority, and place” (1.3.86) found in the “heavens themselves, the planets, and this center” (1.3.85). Achilles and Patroclus, in particular, “vizard” “degree” (1.3.82) by performing skits satirizing the impotence of the generals, drawing attention to the absurdity of someone of Nestor’s age “arming to answer in a night alarm” (1.3.171), “with a palsy fumbling on his gorget,/Shak[ing] in and out the rivet”(1.3.174-5). Dismissive of the generals’ strategic experience, which is comprised of calculative activities such as “contriv[ing] how many hands shall strike/When fitness calls them on” (1.3.201-2), the camp privileges its own ability to operate a “ram” that immediately results in the action of “batter[ing] down the wall” over the “bed-work, mapp’ry, [and] closet-war” (1.3.205) of the generals. This sense of immediacy, while productive when attempting to rile up soldiers for war, also created an anxiety about the way in which military knowledge—however rudimentary—could be manipulated to undermine authority.

The Greek generals’ passivity in intervening illuminates an anxiety among military writers that officers needed to know about all aspects of military organization, particularly artillery, which, on account of its peripheral status and its infiltration by day-laborers and lay-soldiers, posed problems for military hierarchy. Overconfidence specifically in the centrality of reason in “guid[ing]” the “execution” of weaponry, as Ulysses warns Agamemnon, is cause for concern. The satirical treatment of theory-laden military knowledge in Shakespeare’s plays suggests an ideological agreement between theatrical values and those espoused by the disgruntled Greek camp.³⁶ In *Henry 5*, for example, the relevance of theory to military practice is taken to its absurd extreme in the

exchange between the Captains Fluellen and MacMorris regarding the structural integrity of the mines whose digging MacMorris directs. Fluellen, who claims to be well versed in the “disciplines of the war” (3.2.59), or the “Roman disciplines” (3.2.70) lauded by Machiavelli in his *The Art of War*, regards MacMorris as incompetent for digging the mines too close to the enemy countermines, thereby threatening to “plop up all” (3.2.63). In contrast, Fluellen praises Captain Jamy as being of “great expedition and/Knowledge in the’aunchiant wars” (3.2.77-8). MacMorris, however ignorant of these disciplines of war, admits that the “work ish ill/done” (3.2.90), but is more concerned that, rather than storm the besieged city, they “talk [and...] do nothing” (3.2.109), urging that “it is no time to discourse” (3.2.105). His knowledge, however limited, is oriented toward action rather than the type of theoretical “mapp’ry” in which the Greek camp accuses its generals of engaging.

While the plays dispute the value of theory, their stance on experiential knowledge appears more positive. Iago, for instance, represents the competition between the experiential knowledge of a soldier in the field and the “hand that made the engine.” Iago’s major dispute with Othello’s newly minted lieutenant Cassio lies in the latter’s lack of experience. Although a “great arithmetician” (1.1.19), Cassio, in Iago’s eyes, does not deserve the position of lieutenant on account of never having “set a squadron in the field” (1.1.22), nor having known “the division of a battle” (1.1.23) “more than a spinster” (1.1.24). Fed up with the value of “bookish theoric” (1.1.23), Iago writes off Cassio’s “soldiership” as “mere prattle, without practice.” In contrast, Iago cites his own experience, which consists in having “seen the proof/At Rhodes, at Cyprus, and on

[other] grounds/Christen'd and heathen" (1.1.28-30), as grounds for his promotion to lieutenant.

While Iago's argument in favor of experiential knowledge is a persuasive one, his use of the particulars of experience to trick Othello is problematic and embodies the anxieties of early modern military writers. Othello, however cognizant of the role that the "tyrant custom" played in his development as a soldier, holds his faculties of reason in disproportionately high esteem. On the brink of going to war against the Turks, Othello's reassures the Duke that he can "let housewives make a skillet of [his] helm" (1.3.272) in the event that he allows "wanton dullness" (1.3.269) to "seel" (1.3.269) his "speculative and offic'd instruments" (1.3.270) and lets his "disports corrupt and taint [his] business" (1.3.271). By citing his "speculative and offic'd instruments" as the only thing distinguishing his helm, an emblem of military mettle, from a housewife's cooking receptacle, Othello places much faith in his mental capacities, as does the Venetian commission, whose "opinion" (1.3.224) according to the Duke, "throws a safer voice" (1.3.225-6) on Othello despite the existence of a "substitute of most allow'd sufficiency" (1.2.223-4) who could act in his place. In the heat of jealousy, however, Othello lacks the judgment to discern the weight of the particulars that Iago places before him. Iago's status as an ensign, or emblem-bearer, according to Julie Genster, makes him particularly well-suited to perceive details and present them as emblems, as in the famous instance of Desdemona's handkerchief.³⁷ Othello's focus on reason to the exclusion of everything else does not prepare him for the subtle grasp of particulars that Iago has as a soldier well versed in both noticing and acting on the details of war.

To avoid scenarios like Othello's, in which a general is duped by subordinates more in tune with the world of the particulars, early modern military writers strongly urged generals and other military leaders to attain expertise in military technology. For instance, John Sutcliffe advises generals "not onely to have expert Enginers, and menne of excellent knowledge in the arte of Fortification both of Fortes and Campes, conducting of Mines, planning of Batteries, &c. but also to have therein himselfe exquisite knowledge, otherwise shal he be misledde by fantasticall devices of suche as professe and vaunte themselves of the knowledge thy are nothing giltye and purchase hymsefe perpetuelle Dishonoure."³⁸ Similarly, Dudley Digges, in his *Stratioticos* (1578), suggests that the Master of the Ordnance needs experience or else he "shall be abused by audacious and presumptuous persons, that taking upon them the knowledge they utterly want, will shame themselves, dishonor him, and soyle the Enterprise."³⁹ These writers suggest that while the ability to surprise an enemy with artillery suggests a practiced sense of judgment, knowledge of artillery also can be used to mislead people.

The urgency with which these writers stress that officers gain knowledge of what their subordinates do makes one wonder *why* knowledge of artillery and field engagements so easily was used to trick others. As I suggested in the last section, the instantaneous and spectatorial nature of weapons powered by gunpowder makes cannon (and the arts necessary to create cannon) democratically available as a metaphor for intentional action. Moreover, the impressment of soldiers from among the civilian population, as in *2 Henry 4*, when Falstaff admits to preferring the "spirit" (3.2.247) of "spare men" (3.2.246) to the "stature, bulk, and big/assemblance" (3.2.246-7) of "the great ones" (3.2.246-7), made it possible for anyone to become a soldier, for however

brief a period. Falstaff's alignment of "spirit," rather than earthy bulk, as a prerequisite of a gun-toting soldier accords with descriptions of Hotspur and Fortinbras as being spirited, yet rustic, soldiers capable of moving others to action. Leonard Digges, in his *Stratoticos* (1578), disputes the validity of common men claiming to be soldiers, arguing that, "such is the Vanitie of the common sort, that if they have carried Armes, and bene in a few services, they presently thinke themselves worthy the name of perfect Soldiours."⁴⁰ The possibility of these civilian soldiers using the knowledge of artillery to mislead their superiors also stems from the imagined transferability of commonly held artisanal knowledge to military technology. For instance, Falstaff argues that Wart, a candidate for impressment, has a "ragged appearance" (3.2.239) that belies his potential to "charge [...] and discharge [...] with the motion of a pewterer's/hammer" (3.2.240-1) and "come off and on swifter than he that gibbets on the/brewer's bucket" (3.2.241-2). Falstaff's confidence that Wart's extra-military skills will help him in battle, while opening up the virtue of mettle to men of all social levels, only contributes to the potential abuses of military office.

A similar situation of open access is at work in the military manuals that describe the very technical knowledge that theorists fear will be used to abuse power. The plays register the way in which the technical language of war is more threatening than the ballistic technologies themselves. Complaining that her husband Hotspur "murmur[s] tales of iron wars" (2.4.42) in his sleep, Lady Percy, in *1 Henry 4*, describes "all the currents of a heady fight" (2.4.49) as comprising of, among other things, "basiliks," "cannon," and "culverin" (2.4.47), all types of ballistic weapons used in war. That these items and others figure even in the dreamscape of Hotspur's military, mettle-spurred

existence suggests that they are persuasive emblems of war. Unlike Hotspur, who is authentically courageous and upright, in *Henry 5*, the “Ensign Pistol” (3.6.18) demonstrates, as does his fellow ensign Iago, a deep familiarity with only the particulars of war most persuasive of his own expertise. While Captain Fluellen regards Pistol as one who does “gallant service” (3.6.13), Captain Gower understands Pistol to be a “gull” (3.6.63) who “now and then goes/to wars, to grace himself at his return to London under/the form of a soldier” (3.6.63-5). Typical of what military writers most feared as an ill effect of the prevalence of citizen soldiers and the wide availability of military knowledge, Pistol possesses the ability to speak “perfitly in the phrase of war” (3.6.75). According to Gower, soldiers like Pistol would know not only the “the great commanders’/names” (3.6.69), but the exactly details of “where services/were done—at such and such a sconce, at such a/breach, at such a convoy” (3.6.70-2). Captain Gower, cognizant of the persuasiveness of such details, cautions Captain Fluellen to “learn to/know such slanders of the age, or else [...] be/marvelously mistook” (3.6.79-81). Gower’s comments suggest that the very means used to professionalize military mettle and distinguish amateur soldiers from seasoned and experienced ones created the conditions of possibility for mettle to become a more malleable and widely attainable virtue.

Military theorist Roger Williams, who in his *A Briefe Discourse of Warre* (1590) warns his readers that “It is errorr to think that experimented Souldiers are sodeinlie made like glasses, in blowing them with a puffle out of an yron instrument,”⁴¹ brings together a number of threads in this chapter, which has sought to understand the mechanism whereby military mettle, or courage, was imagined to become hard and

metal-like. While I have been arguing for an artisanal mechanism embodied in military metaphors about Vulcan, the Roman god of the forge, Williams' admonition seeks to deny the artisanal connection, arguing that a soldier (and his corresponding mettle) is made not in a "sodein[...] puffe out of an yron instrument," but through the long process of "experiment," or experience. Artisanal mechanisms of mettle certainly do not preclude the experiential creation of mettle over time, as in Othello's hardening through the "tyrant custom" of war. But in denying the effects of gunpowder on actual early modern military practice, Williams ignores that soldiers in fact were blown out of an iron instrument insofar as they were considered to be expendable "food for powder" that was "good enough to toss" (4.2.58), as Falstaff remarks on the low quality of impressed soldiers. Williams' redefinition of military stuff in effect reveals an anxiety about the abrupt way in which soldiers actually were made and the hold that the workings of ballistic weaponry—"yron instruments" that theatrically "puffe[d] out" smoke that intimidated enemies and spurred on soliders—had on early modern imaginings of war and courage. The literary imagining with which I began—Othello's own understanding of the way in which the "tyrant custom" accustomed him to the "flinty and steel [couch] of war"—highlights the inadequacy of accounts of mettle that assume the shared hardness of military custom and metal (as Agamemnon and Paster do) and the necessity of considering the technologies that, in conjunction with the exercise of judgment, enable the cultivation of hard military mettle.

¹ See definition 4 of "agnize, v.": "to recognize the existence of, to acknowledge, confess. *Arch.*" *Oxford English Dictionary Online*, 2nd Ed., 1989
 <<http://www.dictionary.oed.com>> (28 September 2007).

² This and all subsequent references to Shakespeare's plays are from G. Blakemore Evans, ed., *The Riverside Shakespeare* (Boston: Houghton Mifflin, 1997).

² See definitions A.1 and A.2 of "mettle, *n.*" in *ibid.*

⁴ Two recent exceptions to this tendency are: Nina Taunton's *1590s Drama and Militarism: Portrayals of War in Marlowe, Chapman, and Shakespeare's Henry V* (Burlington, VT: Ashgate, 2001), which contextualizes dramatic imaginings of early modern military action in terms of the military manuals of the day, most of which explained the role of military technology and expertise in warfare—especially relevant is her section on "Arms and Men," 132-46; and Chapter Four ("Weapons of Fire and Shakespeare's Dramatic Trajectory") of Adam Max Cohen's *Shakespeare and Technology: Dramatizing Early Modern Technological Revolutions* (New York: Palgrave Macmillan, 2006). While Cohen gives priority to technology as a category of analysis in literature, he does not connect the prevalence of this technology to notions of mettle. Also, his focus on technology is along the Neo-Baconian lines that the Royal Society of London and subsequent generations of historians of science have taken at face value, honing in on printing, clockmaking, and gunpowder, the triumverate of "works" that Bacon mentions in the *Novum Organum* (1620), as emblematic of modernity. I read technology in much broader terms, taking a cue from Antonio Perez-Ramos' *Francis Bacon's Science and the Maker's Knowledge Tradition* (New York: Oxford University Press, 1989), which regards Bacon's interest in "works" not in terms of useful artifacts, but in terms of an epistemological disposition of "maker's knowledge." On the commonplace figure of the military "iron man" Talus in Edmund Spenser's *The Faerie Queene*, see Jessica Wolfe, *Humanism, Machinery, and Renaissance Literature* (New York: Cambridge University Press, 2004), 205. For recent attempts to explain the role of mettle/metal in early modern theatrical understandings of affect in terms of the Neoplatonic resemblance between flesh and the earth, see Gail Kern Paster, *Humoring the Body* (Chicago: University of Chicago Press, 2004) and Mary Floyd-Wilson, "English Mettle" in *Reading the Early Modern Passions*, edited by Paster, Katherine Rowe, and Floyd-Wilson (Philadelphia: University of Pennsylvania Press, 2004). For earlier readings of mettle/metal as a militaristic pun, see Janet Adelman's reference to Lady Macbeth's "mettle" in *Suffocating Mothers: Fantasies of Maternal Origin in Shakespeare's Plays, Hamlet to the Tempest* (New York: Routledge, 1991) and Coppélia Kahn's reference to the male gendering of iron-like soldiers' "mettle" in contrast to women's "melting spirits" in "Mettle and Melting Spirits in *Julius Caesar*," in *Roman Shakespeare: Warriors, Wounds and Women* (New York: Routledge, 1997), 89.

⁵ On the relation between arms and men, see Taunton, 132-46; on the status of armor as a skin-like covering that defines the male self, see *ibid.*, 137; for similar claims regarding Spenser's *Faerie Queene*, see Barry Taylor, "Armour, Flows, and Bliss," in *The Body in Late Medieval and Early Modern Culture*, edited by Darryll Grantley and Taunton (Brookfield, VT: Ashgate, 2000), 138-46; for the same point in medieval French romances, see chapter two ("Chevalrie") of Jane Burns' "Refashioning Courtly Love: Lancelot as Ladies' Man or Lady/Man" in *Constructing Medieval Sexuality*, edited by Karma Lochrie, James A. Schultz, and Peggy McCracken, 111-34 (Minneapolis, University of Minnesota Press, 2003).

⁶ For studies that complicate the notion of the “military revolution,” see Henry Webb, *Elizabethan Military Science: The Books and the Practice* (Madison: University of Wisconsin Press, 1965); Bert S. Hall, *Weapons and Warfare in Renaissance Europe* (Baltimore, MD: Johns Hopkins University Press, 1997); Frank Tallett, *War and Society in Early Modern Europe, 1495-1715* (New York: Routledge, 1992); Taunton.

⁷ Paster, *Humoring*, 37.

⁸ Ibid.

⁹ Ibid.

¹⁰ Ibid., 4n7.

¹¹ Leonard Barkan, *Nature's Work of Art: The Human Body as the Image of the World* (New Haven, CT: Yale University Press, 1975), 34.

¹² Ibid., 33.

¹³ Paster, *Humoring*, 28.

¹⁴ Ibid., 35.

¹⁵ Richard A. Lanham, *A Handlist of Rhetorical Terms* (Los Angeles: University of California Press, 1990), 99.

¹⁶ Vulcan's Greek counterpart, Hephaestus, often is associated with cunning intelligence, or metis, that fuses with metallurgy, as in the case of the intricate web he weaves to ensnare his wife Aphrodite with her lover Ares. See Marcel Detienne and Jean-Pierre Vernant, *Cunning Intelligence in Greek Culture and Society* (Atlantic Highlands, NJ: Humanities Press, 1978), 259-75, 312.

¹⁷ Stephen Orgel, ed. *Ben Jonson: Selected Masques* (New Haven, CT: Yale University Press, 1970), lines 142-5. For a similar scholarly attempt to use alchemy as an *explanans* for absurdity in war machinery, see Michael West, who argues that “the geometrical symmetry of these designs for war machines, which is often carried to absurd extremes, has roots in Renaissance magic and occultism, for it was the alchemical tradition that gave birth to gunpowder” (“Spenser's *Art of War*: Chivalric Allegory, Military Technology, and the Elizabethan Mock-Heroic Sensibility,” *Renaissance Quarterly* 41.4 [1988]: 654-704, 682).

¹⁸ Nick de Somogyi, *Shakespeare's Theatre of War* (Brookfield, VT: Ashgate, 1998), 27.

¹⁹ Somogyi, 29.

²⁰ West, 681.

²¹ Hall, *Weapons and Warfare*, 15.

²² On Machiavelli's reservations about the effectiveness of artillery, see Henry J. Webb, “The Science of Gunnery in Elizabethan Gunnery,” *Isis* 45.1 (1954): 10-21, 15.

²³ Niccolo Tartaglia, *Three Bookes of Colloquies* (London, 1588), 3.

²⁴ William Bourne, *The Arte of Shooting in Great Ordnance* (London, 1587), sig. A2^v.

²⁵ On the longbow-gun debate, see Taunton, 133.

²⁶ Hall, *Weapons and Warfare*, 15.

²⁷ Webb, 11, 17.

²⁸ In contrast to my view of the productive model of action in guns and gunpowder, see Paster (“Nervous Tension,” in *The Body in Parts: Fantasies of Corporeality in Early Modern Europe*, edited by David Hillman and Carla Mazzio [New York: Routledge, 1997]), who, in light of Norbert Elias' “civilizing process,” reads gun barrels as analogous to the vessels that contain and regulate, rather than release, the blood and the

spirits: "In this dynamic, it is the vessels that, in the mode of Bacon's guns barrels, contain the body's internal mechanisms of force and seek to regulate them" (112). Seeking to privilege the fluids of the body as the site of difference in an otherwise densely packed body, Paster reads Bacon's gun barrels as a generalized rigid container for the detonation of infinitely uncontrollable and differentiable gunpowder whose particles explode promiscuously in all directions once ignited. I, on the other hand, see the gun barrel itself as signifying the body of expertise of which it is a product and the military organizational sector (the artillery camp) for which it is an instrument of action.

²⁹ Michael Goldman, *Shakespeare and the Energies of Drama* (Princeton, NJ: Princeton University Press, 1972), 61-2.

³⁰ See Paul A. Jorgenson, *Shakespeare's Military World* (Los Angeles: University of California Press, 1956), 14-5; and Charles Edelman, *Brawl Ridiculous: Swordfighting in Shakespeare's Plays* (New York: Manchester University Press, 1992).

³¹ Tartaglia, 2-3.

³² Tartaglia, 3.

³³ See definitions II.2.a, II.3.a, II.4.a., II.4.b., and IV.6.a. of "craft, *n.*" in the *OED*.

³⁴ John Sutcliffe, *Practice, Proceedings & Law of Armes* (London, 1593), 191-2.

³⁵ Taunton, 166, 166n22.

³⁶ Paul Yachnin recently has suggested that the thematic and linguistic "recognition of the value of theatrical labor" in Shakespeare's plays reveals early modern players to be less merchants of entertainment and more "theatrical artisans." Paul Yachnin, "'The Perfection of Ten': Populuxe Art and Artisanal Value in *Troilus and Cressida*," *Shakespeare Quarterly* (2005): 306-27.

³⁷ Julia Genster, "Lieutenancy, Standing In, and *Othello*," *ELH* 57.4 (1990):785-809, 785, 795. On the rhetorical persuasiveness of the handkerchief, see Joel B. Altman, "'Preposterous Conclusions': Eros, *Enargeia*, and the Composition of *Othello*," *Representations* 18 (1987):129-157.

³⁸ Sutcliffe, 144.

³⁹ Digges, 12.

⁴⁰ Digges, sig. A4^v.

⁴¹ Roger Williams, *A Briefe Discourse of Warre* (London, 1590), 5.

Chapter Four

Teaching Ethical Action through the “Corporal Forms” of Metals in Milton’s Early Prose and *Paradise Lost*

In *Areopagitica* (1644), an address opposing the Cavalier Parliament’s pre-publication censorship as proposed in the Licensing Order of 1643, John Milton famously cites an episode of epic descent from Edmund Spenser’s *Faerie Queene*— an excursion deep into the bowels of Ovidian topography— as a literary exemplum of the advantages of exposing the self to the knowledge of evil:

Assuredly we bring not innocence into the world, we bring impurity much rather: that which purifies us is triall, and triall is by what is contrary [...] Which was the reason why our sage and serious poet Spencer, whom I dare be known to think a better teacher then Scotus or Aquinas, describing true temperance under the person of Guion, brings him in with his palmer through the cave of Mammon and the bowr of earthly blisse that he might see and know, and yet abstain.¹

Milton’s dichotomy between “innocence” and “impurity” initially suggests an unambiguous description of a perfectly created human who has fallen of his or her own accord— an ethical mode governed by an Augustinian sense of free will. Under this moral code, one would endure repeated “trials” by “contrary” to “purif[y]” that sullied state back to its former, prelapsarian pristineness. However, Milton’s citation of temperate Guyon’s descent to Mammon’s cave,² literally a metallic mine and Milton’s prime literary instance of a “trial by contrary,” seems an odd choice to emblemize a process of attaining purity. Mining, usually associated in Ovidian discourse with the fallen Iron Age, would seem to signify impurity.³ The apparent disjunction between the

trials necessary to eradicate impurity and Milton's citation of Spenser's dank subterranean locale as an instance of such trials suggests that a moral code alternate to the Augustinian is at work in Milton's writings—one that Dennis Danielson has described as the Irenean or "soul-making" moral code, which stipulates that humans are created impure even before the Fall, gradually working toward a state of perfection through repeated "trials."⁴ This notion of soul-making relies on the actions of a temperate person like Guyon, who does not live by extremes, but opts for the middle way. This chapter aims to trace this ethical framework, in which souls are "made" perfect through their temperate responses to a series of trials, rather than solely by God's creative spirit, through Milton's invocations of the metallic arts in his early prose and *Paradise Lost*.

Within the framework of the Irenean moral code as illustrated in Spenser's *Faerie Queene*, mining stands out precisely because, as a metaphor, it invites both negative and positive readings, thereby rendering the very act of reading a moral test. On the one hand, mining for precious metals signifies the avarice and ambition of Mammon; on the other hand, as a close reading of Guyon's descent reveals, mining involves an entire realm of knowledge and is only one step in a much longer process of refining base ores into an increasingly purified state. Moreover, this process of refining is replicated immediately after Guyon's descent as a process of cooking and digestion in the kitchen of Alma's House of Temperance, thereby suggesting that the knowledge-seeking represented by mining is as essential a process to temperance as digestion. Milton's two key articulations of his views toward knowledge, *Areopagitica* and *Of Reformation* (1641), compare freely sought knowledge to the search for metals and standardized or controlled knowledge to the commodification of the fruits of that search. There, Milton has harnessed metallic

imagery to describe the threats to intellectual and religious freedom that accompany any top-down attempt to limit or control knowledge or practice.

Milton deploys the flexibility of metallic imagery to encapsulate the ethics of knowledge, which are predicated on the fact that evil is indistinguishable from good, so that every act of knowing is a trial of temperance between the extremes of ignorance and folly. In the case of Guyon, who resists Mammon's appeal to his appetite for treasure, his curiosity is tested when Mammon lures him into the laboratory to satisfy his desire to know about the origins of the metals. In Guyon's example, the metallic arts represent both the objects of appetite and the objects of curiosity and truth-seeking. Milton describes both the perversions and exemplary instances of that seeking after truth in terms of the negative and positive aspects of metalworking, playing on the analogical relation between the effects of mining and metalworking on the health of the body politic.

Milton's poetry likewise underscores the importance of sustaining the free search for knowledge through his use of metallic metaphors. But in *Paradise Lost*, he goes even further, using a discourse of metals to describe an ethical engagement with purity and impurity. Like Spenser, Milton imagines temperance and the actions of an ethical self as simultaneously a digestive and refining experience. As an extension of what Michael Schoenfeldt has described as Milton's "alimantal vision" of a "digestive universe,"⁵ metallic imagery allows Milton to exploit further the continuum of impurity to purity. The impetus behind Milton's outward, metallic manifestation of the ethical self is to teach moral behavior in an easily digestible form. Taking a cue from Spenser's vivid literary pedagogy, Milton thematizes in *Paradise Lost* the utility of poetry, its instrumentality in teaching moral behavior, through the notion of "corporal forms"

(5.573), metaphors that Raphael uses to explain spiritual matters to Adam. The discrepancy between the corporal and the spiritual realms follows Milton's views on poetry in *On Education*, in which he says that "Poetry," on account of its being "less subtle and fine" than "Rhetorick," and therefore more "simple, sensuous and passionate," lends itself to "religious [...] glorious and magnificent use [...] both in divine and humane things."⁶ The incongruity between the "less subtle and fine" vehicle of poetry and the "glorious and magnificent" tenor that Milton purports to be the proper subject of poetry is emblemized in the discrepancy between the poetic instance of Guyon's descent to Mammon's cave and the moral ideal of temperance that the descent exemplifies. In *Paradise Lost*, the corporal form directed toward the implied reader of the epic and emblematic of the interplay between impurity and purity depends on the speaker's descriptions of the metallic arts as deployed by the fallen angels and the Sons of Man. In these and other examples of Raphael's use of "corporal forms," the vehicle outweighs the tenor in terms of its materiality and its appeal to sense. The "corporal forms" of the metallic arts appear in key moments of Milton's descriptions of his Irenean universe: the conversation between Raphael and Adam, the descriptions of creation, the depictions of Hell, and the battle in Heaven all prod our recognition of the crucial blend of impurity and purity in all human experience.

The inconsistency between earthy form and ethereal essence, as I will show in *Paradise Lost*, represents not only Milton's understanding of the pedagogical efficacy of poetry, but the way in which humans understand a God who chooses to communicate through works that he creates under metallurgical conditions. In the poem, God creates his works from the repository of elements in Chaos, which in Milton's spiritual

topography resides just outside the gates of Hell, the venue for the most ambitious mining and metallurgical projects in the poem. Mining, for example, on account of its dependence on fire, its allusion to the Ovidian Iron Age, its extraction of dank materials usually ascribed to Hell, and its satisfaction of greed, is often understood as an activity emblematic of a fallen state, especially since, in *Paradise Lost*, the fallen angels tend to engage in it. Any readings of *Paradise Lost* that see an epistemic disparity before and after the Fall, however, neglect the fact that many prelapsarian moments bear the marks usually associated with impurity, such as fire, mixture, and art. As I will show, the moments in *Paradise Lost* that explicitly depict mining and metalworking reveal that art and the manipulation of the material world are not fallen activities; in fact, the speaker of the poem tends to praise these arts. The scenes that depict the practice of the metallic arts attempt to capture the way in which, as in Milton's prose texts, avarice and diligence coexist in one vivid image and provide a hermeneutic and ethical test for the reader.

Why would Mammon's cave—literally a mine—inspire Milton to praise Spenser's skill in teaching readers to "see and know, and yet abstain?"⁷ For Milton, the mine provides an example of the "regions of sin" that every Christian must "scout" in order to test his or her faith and obedience.⁸ Guyon's ability to survive the trial despite being tempted by treasure of all kinds makes him Milton's poster-child of temperance. But, such a trial would seem to test not Guyon's intellect, but his appetite. The key feature of Guyon's descent, therefore, is not the mine itself, but the laboratory in which Mammon processes the ores his workers unearth. Guyon's questions to Mammon reveal that his test resides not in his abstaining from avarice, but in his temperance in

knowledge. Moreover, Guyon's descent teaches him that grubbing for money through mining and metalworking is not unambiguously evil. Rather, the will or motivation behind those actions is to be questioned. The structural parallels between the cauldrons in Alma's Kitchen (the stomach of her House of Temperance) and the crucibles in Mammon's cave (the bowels of the earth) suggest that the ethics of temperance depend as much upon the metallic arts as on digestion.

Guyon's journey is valuable to Milton's notion of a temperance inculcated by reading because it depicts an intellectual rather than an appetitive trial. Curious "to weet, whence all the wealth late shewd by [him]/Proceeded" (2.7.38.4-5), Guyon embodies Milton's ideal reader of postlapsarian texts because he opts to know about Mammon's evil rather than engage in it himself. Yet his curiosity also reveals his own bias regarding the origins of Mammon's treasure. When Guyon presses Mammon to show him the origins of his wealth, Mammon reveals not a scene of ready-made, stolen wealth "bereave[d]/From rightfull owner by unrighteous lot" (2.7.19.3-4) and "blot[tet]" by "bloud guiltinesse or guile" (2.7.19.5) as Guyon expects; rather, he discloses an entire alchemical laboratory replete with a "hundred raunges" (2.7.35.4) and a "hundred furnaces all burning bright" (2.7.35.5), where his helpers "melt the golden mettall, ready to be tride (2.7.35.9). Mammon's workers, in spite of their being "deformed creatures" (2.7.34.7), seem praiseworthy for the "swinck[ing]" and "sweat[ing]" (2.7.37.9) they undergo to refine metals, a material enactment of the effects that Guyon's temperance will have on his gradually perfected soul. Their work includes sustaining the temperature of the furnace by "repair[ing]" the "dying bronds" (2.7.36.3) with "yron touns" (2.7.36.4) and "sprinckl[ing]" (2.7.36.4) them "with liquid waves" (2.7.36.5).

Maintaining a hot furnace allows them to “scum the drosse, that from the metal came” (2.7.36.9) and “stir the molten owre with ladles great” (2.7.36.8). Guyon, however, recognizes their labors as “vaine shewes” meant to “abuse” (2.7.39.5) or deceive him. Touting his laboratory as “fountaine of the worldes good” (2.7.38.6), Mammon asks Guyon to “chaunge [his] willful mood” (2.7.38.8) and accept the gift of riches now that his curiosity has been sated. Mammon therefore leads Guyon to the laboratory not simply to satisfy his curiosity, but to “entrap” (2.7.34.9) him with a vision of the industriousness of his servants, a scene more likely to tempt Guyon than treasure guarded by the “ugly feend” (2.7.26.7) in the “house of Richesse” (2.7.24.9). By exposing himself to Mammon’s evil and the evils of his own biases, Guyon derives the benefits of learning about things contrary to what is accepted as true and good.

Mammon’s eventual exit from the cave reveals that a metallurgically-informed search for truth depends on the vital digestive processes that sustain life; these processes of refining food for the body replicate in miniature the same refining processes necessary to bring metals into being in the core of the earth. Moreover, their deployment by forces oriented toward the maintenance of bodily health, rather than toward the accumulation of riches, illustrates the flexibility of metallic imagery. Mammon exits the cave not because he finds it a horrible place or because he has had his fill of evil, but because his “vitall powres gan wexe both weake and wan/For want of food, and sleepe” (2.7.65.2-3). Guyon’s rather mundane reasons for leaving the cave intended to test his temperance in knowledge point to a physiological phenomenon central to Milton’s universe and the Irenean moral code he derives from it: one cannot know unless one has eaten. Mammon’s workers’ actions are paralleled in the stomach-like kitchen of Alma’s House of

Temperance, which Guyon visits after surfacing from Mammon's cave. Furnished with "raunges" (2.9.29.2) and "a mighty furnace" (2.9.29.6), the kitchen contains the same equipment that resides in Mammon's alchemical laboratory. Like Mammon's workers, who "scumd the drosse" and "stird" the contents of the cauldrons of molten metal, the helpers in Alma's kitchen "remoue the scum" (2.9.31.7) from steaming broths. The parallels between Mammon's laboratory and Alma's kitchen reveal that the same actions can be either laudable or evil depending on the intent of the practitioner.

The necessity of knowing evil to know good depends on Milton's description of truth in *Areopagitica* as a "homogeneal, and proportionall" "body" that allows us "to be still searching what we know not, by what we know, still closing up truth to truth as we find it."⁹ This "golden rule," which Milton believes to apply to "Theology as well as in Arithmetick," underscores the Irenean ethical view emblemized in Guyon's descent because it argues that sin differs from truth only in degree rather than kind. Only by "searching" for truth through the evil counterparts "proportionall" to it, as Guyon does, can one hope to approach truth itself. The link that Guyon's example forges between the body of the world and the body of the self assists Milton in explaining that one needs to attain knowledge not simply for one's edification, but for becoming what Milton calls in *Paradise Regain'd* a "living oracle" of truth like Christ.¹⁰ As Stanley Fish has argued, *Areopagitica* is not about books or censorship per se; rather it advocates that a Christian's knowledge of both good and evil is intrinsic to his or her membership in the "incorporate body" of truth embodied by Christ.¹¹

Milton couches his critique of censorship in terms of “searching” for and “finding” the “incorporate body” of truth through the “proportional[ly]” less true means of mining the body of the earth. Quoting a passage from Proverbs 2, Milton laments:

What a collusion is this, whenas we are exhorted by the wise man
to use diligence, to seek for wisdom as for hidd’n treasures early
and late, that another order shall enjoyn us to know nothing but
by statute.¹²

By associating mining with the use of “diligence” and the search for “wisdom,” Milton strengthens his identification of the Cave of Mammon as an emblematic space for a trial of temperance. The purported value of the “hidden treasures” of wisdom speaks to the importance of trying the self in such a fashion. But, Milton invokes mining more for the intensity of the quest itself. For Milton, mining bespeaks an enthusiasm that would drive one to engage in such an arduous task both “early and late.” Moreover, Milton’s description of this intense material engagement with knowledge makes censorship, which “enjoyn[s] us to know nothing but by statute,” all the more abominable. He pursues this notion of censorship as “knowledge by statute,” likening it to the standardized practices of royally-issued monopolies on goods and practices, which albeit abolished in 1623 with the Statute of Monopolies, still carried a royalist and elitist charge when Milton addressed Parliament in 1644. To “know nothing but by statute” would mean that a mere twenty licensers would be authorized to judge “all the invention, the art, the wit, the grave and solid judgement which is in England.”¹³ Censorship essentially meant putting a stop to the production of knowledge in all its forms, be it intellectual or technical.

To emphasize that such a loss of knowledge injures the dignity of the English nation, Milton alludes to an instance from the Bible when the Israelites are “not allow’d

the sharpening of [their] own axes and coulters, but [...] must repair from all quarters to twenty licencing forges.”¹⁴ By representing knowledge in terms of utilitarian, iron implements, Milton both elevates technical learning to something worthy of development and belittles the censors who dictate of what that knowledge should consist. He argues that licensing, in the interests of putting a “manuall stamp” on “truth and understanding,” requires them to be “sifted and strain’d with their [the licensors’] strainers.”¹⁵ Such a process of standardization, rather than improve the quality of learning in the realm, reduces truth to mere “wares [...] monopoliz’d and traded by tickets and statutes.”¹⁶ The censors’ commodification of truth recalls Milton’s example of the wealthy man who, “find[ing] Religion to be a traffick so entangl’d” that he outsources its “piddling accounts” to “som factor,” turns his religion into a “dividuall movable” or a portable piece of property easily divisible among heirs.¹⁷ Such prostitution of truth, with its emphasis on ease and comfort in understanding, disregards the warlike struggle implicit in Milton’s depiction of the search for knowledge through mining. Milton sees the natural next step of a man “labouring the hardest labour in the deep mines of knowledge” to “furnish[...] out his findings in all their equipage,”¹⁸ weaponry reminiscent of an earlier passage in *Areopagitica*, in which he describes the “plates and instruments of armed Justice” hammered out by “anvils and hammers waking” in the “shop of warre” to protect “beleaguer’d Truth.”¹⁹ This additional military significance of the mining-knowledge analogy underscores the indignities posed to the English nation, the Church, and its believers by a censorship that seeks to stop the knights of truth emblemized by Guyon from “scout[ing]” the “regions of sin.”

Milton's adamancy against licensing the knowledge in books, and the soul-making ethics implied by his opposition, according to Dennis Danielson, derives from his objections to the Laudian Church reforms of the 1630s, which advocated visually coherent and consistent forms of worship.²⁰ The physical separation between clergy and laity signified by sartorial and architectural innovations such as vestments and communion tables set off by rails would perhaps not stir as much controversy had opposition to such changes not been suppressed through censorship.²¹ This push for visual uniformity was so strong that it silenced a rising theological controversy over predestination, reducing all discussion to the finer points of "Laudian style."²² Milton counters the Prelates' fear of sectarianism, the reason for their institution of the reforms, by arguing that no man can "sever the wheat from the tares, the good fish from the other frie," a task reserved for the "Angels Ministry at the end of mortall things."²³ That Milton's objections to censorship emerge out of his disagreement with the Laudian Church reforms reaffirms Fish's view that Milton champions truth through error not for epistemological reasons alone, but to participate in a community united in its desire to emulate Christ, a "living oracle" of truth. Milton desires to be a member not of a "grosse conforming stupidity,"²⁴ but of the "incorporate body" of Truth whose "perfection" lies in the "moderat varieties and brotherly dissimilitudes" comprising the whole.²⁵ To deny the diversity of belief is to deny the collective health of this body of Truth, whose members rely on a counterintuitive method of knowing good through evil.

One of the implications of belonging to such a community is that one's actions affect the whole body of believers. To this end, Milton describes the literal and metaphorical licensing of belief by the Prelates as resulting in the sickness of the body of

Truth. Correspondingly, mining, which in *Areopagitica* represents the search for the “hidden treasure” of knowledge in the communal body of the earth, transforms into something negative. In *Of Reformation* (1641), Milton harnesses the negative effects of mining to criticize the ill effects that the Bishops’ avarice has on the health of the body politic. Their love for wealth, symptomatic of their privileging of “outward conformity” in Church reforms, “draw[s] down” all interaction between the self and God.²⁶ By emphasizing the outward shows of religiosity funded by the treasure of the people and the realm and “cour[ing] over their gold,” the Bishops resemble the Antichrist, who “is Mammons son.”²⁷ To add insult to injury, Milton finds their idolatry to be no different from that of Catholic popery. Milton sees little difference between the Bishops’ insistence on the “idolatrous erection of Temples beautified exquisitely to out-vie the Papists”—a project that Milton believes to be “an excessive wast of Treasury”²⁸—and the Pope’s “Alchymy” of indulgences, which is designed to “extract[s] heaps of gold, and silver out of the drossie *Bullion* of the Peoples sinnes.”²⁹ Whereas the Pope transmutes the substance of individuals’ sins into gold, the Bishops, whose courts Milton accuses of being rife with “extortions,” “open corruptions,” and “hungry and ravenous Harpies,” are more pernicious for the “masse of money” their institutions draw from the “veines into the ulcers of the Kingdome.”³⁰ Such measures to “min[e] and sap[...] the out-works and redoubts of Monarchy” by rendering the realm a malnourished skeleton “strike at the very heart, and vitals.”³¹ By perpetuating a system of corruption that courses through the kingdom, the bishops’ courts affect individuals who comprise the realm. Rather than heal with “balm” the “wounds” their courts inflict on the populace, the Bishops hope to extract more wealth from the people by injecting into them the alchemical raw materials

of “oil of Tartar, vitriol, and mercury.”³² Milton’s use of the metallic arts to describe the corruption of the Bishops indicates the pervasiveness of their fraud throughout the body of the kingdom. More importantly, it expresses the idea that the search for knowledge—represented here by mining—when thwarted or limited by “license” or decree, degrades the lofty and the noble into the idolatrous and the base.

In contrast to the metallic metaphors Milton uses to attack the Bishops’ idolatrous and greedy embrace of the sumptuous regalia that serves to externalize the unity of the Church, Milton’s use of metallic language in *Areopagitica* addresses the ways in which knowledge can remedy the ills brought about by the Prelates’ efforts to standardize and unify the kingdom under one false banner of truth. Whereas the Prelates sap the life out of the kingdom by pressing for the material needs of the Church, so books preserve the life-force of the authors who write them, the readers who consume them, and the entire realm of which authors and readers form a part. Books not only “preserve as in a viol the purest efficacy and extraction of that living intellect that bred them,”³³ but are beneficial to the intellectual and moral health of readers, as they are “useful drugs” and “working minerals” that “temper and compose effective and strong med’cins.”³⁴ The intellectual benefits contained within these legible minerals extend throughout the entire body politic and bespeak the general health of the nation: “For as in a body, when the blood is fresh, the spirits pure and vigorous, not only to vital, but to rationall faculties [...] it argues in what good plight and constitution the body is.”³⁵ Milton argues that a nation that possesses enough vitality not only to “guard its own freedom and safety,” but to generate “new invention” signals its rebirth and shedding of the “wrincl’d skin of corruption” embodied by the Prelates.³⁶ The vitality that knowledge brings to the body of a nation

therefore would make any attempts to reap profit from censorship harder than alchemy itself: Milton anticipates that “sublimat[ing]” any benefit from the licensing of books would prove to be “a harder alchymy then *Lullius* ever knew,” referring to a Spanish chemist of the thirteenth century.³⁷ In contrast, a good reader, through his or her own reasoning and wisdom, “like a good refiner can gather gold out of the drossiest volume.”³⁸ In the final tally, privileging individual judgment over enforced statutes supports the goal of maximizing the knowledge of good available through evil.

Milton stresses that the Prelates’ concern over the coherence of the body disallows the ambiguities of truth to which humans are subject; rather, freely understanding these ambiguities comprises the true test of faith and obedience. Milton’s positive and negative deployment of the metallic arts—and their relevance to accounts of avarice and diligence—embodies the ambiguous nature of truth itself. His citing of Guyon’s trek to Mammon’s cave as an exemplary moment of trying the self by exposing it to evil, in turn, implicates the pursuit of truth, as imagined through the metallic arts, within the maintenance of a temperate self. The association between the metallic arts and temperance elevates the metallic arts above their usual fallen and corrupt status to endeavors that describe the ethically acting self.

Metals in *Paradise Lost* span pre- and post-lapsarian time and the realms of Heaven, Hell, and Earth, suggesting that metals possess some malleability in terms of what they can signify. Although some see mining in Milton through only an Ovidian lens, and therefore as a kind of fallen activity worthy only of the fallen angels in Hell, Milton’s use of the metallic arts throughout the time and space of his epic universe suggests

something different. In this spirit, Milton, rather than vilify the metallic arts, deploys them to describe the need to exhibit temperance in knowledge. As Milton's descriptions in *Paradise Lost* of the metalworking of the fallen angels suggest, the metallic arts and metals exhibit both good and evil qualities depending on the ends to which they are used. At times, even the ends do not disrupt the inherently good processes that the evil-minded rely on for their handiwork. Since after the Fall, the notion of Edenic labor as benevolent stewardship is impossible, Milton opts for processes derived from the fire-based arts, which are modeled on God's own creation of the universe from the primordial chemical soup of chaos, to describe the intellectual counterpart to alimentary tests of temperance. The similarities between these artistic actions and God's creative spirit, in turn, cannot but suggest that the metallic arts circumscribe actions charged with ethical import in Milton's prose and poetry.

The metallic arts therefore extend the ethical tests embodied in acts of eating and digesting described in detail by Schoenfeldt and others to acts of knowing and learning through the material of the earth. In so doing, these arts support Raphael's advice to Adam in Book 7, that "knowledge is as food, and needs no less/Her temperance over appetite" (7.126-7). Raphael urges Adam to keep temperance in knowledge and limit his thought to earthly rather than celestial things: "Therefore from this high pitch let us descend/A lower flight, and speak of things at hand/Useful (8.199-200). Raphael dissuades Adam and Eve from contemplating the abstractions of the heavens, instead encouraging them to limit their ambitions by "direct[ing]/[their] knowledge" (5.507-8) to the "prime wisdom" (8.192) of "daily life" (8.191), which "solid good contain[s]" (7.93). Raphael's way of explaining the universe to Adam resonates phenomenologically with

the solid wisdom of daily life. Just as Milton relies on the poetic medium of Guyon's descent—a passionate form less “suttle” than rhetoric—so Raphael, the “divine instructor” (5.546), enlightens Adam “by lik'ning spiritual to corporal forms,/As may express them best” (5.573-4). Raphael's method of instruction therefore inculcates temperance in Adam by requiring that he understand truth through a material and corporal language.

This prelapsarian pedagogy, by explaining the spiritual realm with the solid material of forms recognizable to humans, affirms the unity and inherent goodness of matter in the universe, a heterodoxy known as material monism.³⁹ Raphael explains that all created things stem from “one first matter” differing only in its “[...] various forms, various degrees/Of substance” (5.472-4), which reveals to Adam a spectrum of creation in which the higher orders of creation depend on lower ones to “ascend to God” (5.512).⁴⁰ Raphael's description of this monistic universe underscores Milton's views on matter as inherently good. Milton asserts in *On Christian Doctrine* that “it is not the matter nor the form which sins.”⁴¹ Even the “original matter,” Milton argues, which bears a resemblance to the Hell, was neither “an evil thing” nor “worthless.”⁴² In fact, Milton goes as far to say that it was “good, and it contained the seeds of all subsequent good.”⁴³ Only when matter “has gone out from God and become the property of another” do the “calculations of the devil or of man,” which “proceed from these creatures themselves,” “infect” and “pollute” matter, transforming it into a “mutable state.”⁴⁴ Even actions themselves are not bad, but “intrinsically good;” it is merely the “misdirection or deviation from the set course of law” that constitutes evil.⁴⁵

That Adam interprets this inherently good monistic universe as a “scale of Nature” (5.509) that requires each member to engage in the “contemplation of created things” (5.511) in order to ascend the ranks of material substance toward God has been interpreted as evidence of Milton’s sympathy for Baconian experimental science.⁴⁶ Following William Poole’s recent caveat against simply assuming Milton’s Baconian leanings, I hesitate to align the Restoration-era Milton with experimental science because of its associations with the Royal Society, an institution backed by Charles II.⁴⁷ Moreover, such progressive readings of Miltonian knowledge making, according to Poole, presume that prelapsarian pronouncements such as Raphael’s have a bearing on the postlapsarian activity of gaining dominion over the earth to reinstate the prelapsarian condition.⁴⁸ I disagree with the Baconian readers of Milton, as well as with Poole, because both presume a stark division before and after the Fall. Demarcating such clearly defined points of purity versus impurity misses the point of Milton’s poetry, which is to initiate Christians into Godliness through the exercise of reading and understanding the difference between good and evil for themselves.

Poole’s distinction is useful nonetheless for describing the ways in which the materialist, fire-based epistemology upon which the metallic arts are based have come to be seen as symptomatic of the fallen state. Poole’s epistemological division before and after the Fall hinges on a description of Eve’s Edenic “Gardning Tools” as the products of an “Art yet rude,/Guiltless of fire had formed, or Angels brought” (9.391-2).⁴⁹ The term “guiltless” may seem to suggest a moral degeneracy to readers of Milton who see the arts as fallen and corrupt. The *OED*, however, rather than define “guiltless” in moral terms, describes it as not having familiarity, experience, or use of something.⁵⁰ Following

this neutral connotation of “guiltless,” and in contrast to Poole, I would argue that the division before and after the Fall has no bearing on the moral valence of fire-based knowledge, though it describes the type of art involved in making Eve’s tools. This description would seem to indicate that Eve’s tools were made by means of an art that did not rely on fire. But, keeping in line with the notion of “corporal forms” as pedagogical aids, the ethereal register of the phrase “or Angels brought” implies that the speaker is using the first part of the lines, “Art yet rude,” as its earthly counterpart. In other words, the speaker is trying to convey that the tools were not of this world because they were made neither of fire, as humans understand that substance, nor by human hands, but by angels, who were well versed in fire.

If fire in Promethean fashion marks the end of innocence, it nonetheless is prelapsarian given the presence of chaos before creation itself. That fire is at the top (just below ether) of the “food chain” of the elements is significant because it is the element toward which an obedient and temperate human must gravitate if he or she desires to transcend the earthly bounds of his or her body. Chaos, which Milton locates just outside the gates of Hell, bears some resemblance to that fallen realm. The four elements, comprised of the “pregnant causes” (2.913) of “sea,” “shore,” “air,” and “fire” (2.912), God’s “dark materials” (2.916), are “mixed/Confusedly” and “fight” constantly (2.913-4). According to Uriel’s report, God’s “word” and “voice” alone made the “formless mass” of the world come “to a heap” and the “vast infinitude confined” (3.708-11). This theory of creation, known as “chaology,” commonly was associated with the metallic arts because it represented the manipulation of elements with fire, the same way that metals were imagined to come into being.⁵¹ In fact, an officer of the Society of the Mines Royal,

Sir John Pettus, wrote a chemically-inflected gloss on *Genesis* called *The Volatiles from the History of Adam and Eve* (1674). Michael's description of Armageddon reasserts the chaological beginnings of the universe by describing the way in which the new world will be created out of the dregs of the present world. Not only will Satan's kingdom "dissolve," but "New Heavens" and "new Earth" will be "raise[d]/From the conflagrantly mass, purged and refined" (12.546-9). This description of Armageddon resonates with Milton's objection in *Areopagitica* to censorship, that any definitive distinction between good and evil will be made by angels, not humans, at the end of time.

Even the realm of Heaven is not immune from the materiality of metals. Satan's troops, for instance, mine "materials dark and crude" (6.478) from Heaven's "Ethereous mould" (6.473) in order to make gunpowder-powered cannons to use against the heavenly forces. God's own deployment of "Warr" (6.712), a synecdoche Milton uses for a complete arsenal, all seem to be made of, if not metal, then some other massy substance that has weight and can be tempered. For example, the arms carried by the Heavenly angels weigh them down, limiting their range of movement when Satan strikes them with his newly forged weaponry: had they been "unarm'd they might/Have easily as Spirits evaded swift/By quick contraction or remove" (6.595-7) in response to Satan's "engins" (6.518). The effects of the weighty arms on God's troops suggest a corruption of their otherwise ethereal state, a corruption paralleled by Satan's troops, whose former glory as "Spirits of purest light" (6.660), which made them "equal in their Creation" (6.690) to Heaven's angels, had "now gross by sinning grown" (6.661). Michael's sword from the "Armorie of God" (6.321) is of a similar substance that was "temperd so, that neither keen/Nor solid might resist that edge" (6.322-3). The strength attributed to Michael's

sword, on the one hand, reveals its divine origins; on the other hand, the fact that it is “temperd” suggests that it is an artifact gradually made stronger by a metallurgical process of tempering. Such a process presumes that the material in need of tempering is lacking in strength that can be imparted either by a process of successive heating and cooling or by mixing that material with something else, usually of baser quality. The metallic tempering of Michael’s sword, as well as the other metallurgical accoutrements of the war, parallels in the material makeup of Heaven the gradual progression toward Godliness contained within Milton’s monistic universe.

Milton’s use of various instances of material mixture to describe Adam and Eve in Eden implies that the self was not pure before the Fall. The Irenean view of morality can be seen in Milton’s use of the term “mixture” to describe Adam and Eve before and after the Fall, suggesting that Milton believes purity to be a relative rather than an absolute term. The lack of homogeneity in creation is supported by Adam and Eve’s mixed composition of earth and spirit—an attribute that incenses Satan, who finds bowing down to creatures less refined than he to be an abomination. In fact, their constitutional mixture is so pervasive that Adam and Eve cannot be saved solely by the trials they endure on earth; rather, Christ, a spiritually sanctioned alloy, has to “join human nature to his own” (3.282) in order to absolve the permanent mixture of original sin.

One could argue that the Fall, which Milton describes as an “unharmonious mixture foul” (11.51) that renders the pair materially incompatible with the ethereal environs of Paradise, as “gross to air as gross,/And mortal food” (11.53-4), introduces mixture into an otherwise untouched universe. However, Adam’s prelapsarian elevation

of touch—a mere appetite “vouchsafed/To cattle and each beast (8.581-82) and unworthy “to subdue/The soul of man” (8.584-5)—above all other senses suggests otherwise.⁵² For Adam, “touching” Eve “transports” him to a place where passion, which one would imagine to be symptomatic of a fallen state, rules over reason: “Transported touch; here passion first I felt,/ Commotion strange” (8.530-531). Michael Schoenfeldt cites this moment—one of many, he maintains, in which Milton “teases us with a fallen lexicon that adumbrates the ultimate fate of Adam and Eve”⁵³—as symptomatic not only of debates over the nature of passion in the wider culture of early modern England,⁵⁴ but of Milton’s location of redemption in the utterly human realm of feeling and affect.⁵⁵

As biased as Raphael is against Adam’s embrace of passion, misunderstanding it as base sexuality rather than the conjugal companionship Adam imagines it to be,⁵⁶ Raphael’s advice for counteracting the “charm of beauty’s powerful glance” (8.533) presumes an impure state of Paradise. He suggests that Adam exercise the “skill” (8.572) of “self esteem” (8.573) and “weigh with her thyself;/Then value” (8.570-1). The reference to weighing before the Fall seems misplaced given God’s golden scales at the end of Book 4, which “weigh” Satan once and for all and reveal “how light [and] how weak” he and his forces are compared to the troops of Heaven (4.1012). Not only would one not expect Adam to err in his estimation of Eve in comparison to himself, but the act of weighing itself presumes the existence of corruption. In a completely corruption-free environment, nothing would require weighing or comparison because presumably everything would be perfect, free of defect, and self-sufficient.

Despite their reputation as fallen arts, the metallic arts encapsulate the spectrum of impurity and purity implied by Milton's universe—a scale composed of moral mixtures that require an active intellectual engagement to dissect and understand them. The overwhelming presence of unrefined precious metals in Milton's Hell— signified by the “glossy scurf” (1.672) adorning its hills and the blazing temperatures produced by its “one great furnace flamed” (1.62)— would seem to underscore the fallen status of the substance of metal and the metallic arts. Most readings of Milton's references to Hellish mining interpret it as a kind of fallen labor that alienates the self from the world, much in the way that Adam and Eve's sin alienated them from God.⁵⁷ For example, William Kerrigan has argued that the mining of Hell is opposite to the “georgic” mode of Adam and Eve's prelapsarian labor.⁵⁸ While this distinction makes sense given that no vegetation grows in Hell, it does not hold up to the praise that the narrator of *Paradise Lost* lavishes on the metallic arts. The speaker of the poem lauds the metallic arts in ekphratic fashion while criticizing the perverse purposes to which such arts are put, a move that supports Milton's contention in *On Christian Doctrine* that all matter is good insofar as it is used for good by actors with good intentions. Ekphrasis here is significant because it is not neutral description; rather, as Leonard Barkan has argued, the “decipherment” central to ekphrasis is a “fundamental hermeneutic activity” that reveals the describer's own interests and biases.⁵⁹ So the speaker of *Paradise Lost*, in describing the devilish mining and processing of metallic substances, enacts the very hermeneutic process of interpretation that the Milton of *Areopagitica* instructs Christians to cultivate through reading. The descriptions of mining, by showing the good and bad elements of an

activity typically unambiguously associated with greed and violence, instruct the reader how one may know good through evil.

However critical Milton's speaker is of the fallen angels' mining, he nonetheless endorses the metallurgical refining pursued by them because it illustrates the value of engaging in useful things. In the speaker's description of the mining and metallurgy of Hell, the labor of the Spirits "reprobate" (1.697) elevates the metallic arts above the mere satisfaction of the avarice of those such as Mammon, whose "downward bent" in Heaven demonstrated his excessive admiration for "trodden gold" (1.681-2):

Soon had his crew
Op'nd into the Hill a spacious wound
And dig'd out ribs of Gold. Let none admire
That riches grow in Hell; that soyle may best
Deserve the precious bane. And here let those
Who boast in mortal things, and wond'ring tell
Of *Babel*, and the works of *Memphian* Kings
Learn how their greatest Monuments of Fame,
And Strength and Art are easily out-done
By Spirits reprobate, and in an hour
What in an age they with incessant toyle
And hands innumerable scarce perform.
Nigh on the Plain in many cells prepar'd,
That underneath had veins of liquid fire
Sluc'd from the Lake, a second multitude
With wond'rous Art found out the massie Ore,
Severing each kind, and scum'd the Bullion dross:
A third as soon had form'd within the ground
A various mould, and from the boyling cells
By strange conveyance fill'd each hollow nook (1.688-707)

Whereas the speaker's description of the mining "crew" (1.688) ends with a moralizing caveat to the reader against "admir[ing]" the "precious bane" of Hell, the description of the "second multitude" (1.701) begins with a comparison to Babel and Memphis.

Although the editor of the *Riverside Milton* argues that such a comparison to the fallen angels' labor stems from the fact that Babel and Memphis were the commonplace sites of

cupidity,⁶⁰ I argue that the speaker's criticism of Babel and Memphis endorses the refining work of the "Spirits reprobate." Able to perform the same task in an "hour" (1.697) that took humans "an age" (1.698), these spirits appear diligent in respect to lazy, ineffectual humans. The speaker enthusiastically describes the processes of "found[ing] out" (1.703), "severing" and "scum[ming] the Bullion dross" as a "wond'rous Art" (1.704). The description of art as "wond'rous" is unique in *Paradise Lost*, as most references to art in the poem, according to Ann Torday Gulden, are negative.⁶¹ In contrast to the miners, who violently extract "ribs" (1.690) or naturally refined metal from the earth, the "second multitude" has to melt and separate or found out their "ore" into usable metal.⁶² In addition, the metal they use is distinct from that being mined because they are making cylindrical pipes for cannons, usually forged by bell-founders in brass, an alloy of tin and copper. The founding angels' mixing of an alloy that requires them to separate "Bullion dross" (1.704) from the more valuable parts of the metal pays homage, in an understated way, to Milton's earlier pairing of the refining trial and the truly obedient Christian subject in *Areopagitica* and *Of Reformation*.

Michael foretells the dangers of intemperate knowledge when he recounts to Adam the ill fate of the Sons of Men, Tubal-Cain's descendants, known for their artistic skill. The Sons of Men undertake metallic arts in Michael's vision, but are criticized not for their performance of arts, but for neglecting their duties to God. Michael shows Adam a plain divided into three parts: one with musicians, the second with a forger, and the third of scholars. The evil qualities of the scholars' qualities emerge when, confronted with a tent full of beautiful women, they "let their eyes/Rove without rein" (11.585-6). While Adam finds the amorous scenes to show nature "fulfilled in all her ends" (11.602),

Michael objects on the grounds that the men's artistic pursuits are at odds with their lascivious desires: "studious they appear/Of arts that polish life, inventors rare,/Unmindful of their Maker, though his spirit/Taught them, but they his gifts acknowledged none" (11.609-12). Although Roy Flanagan argues that the arts they practice, in "polish[ing] life," are negative, the description of the forgers in the field represents an art that is not corrupt:

In other part stood one who at the Forge
Labouring, two massie clods of Iron and Brass
Had melted (whether found where casual fire
Had wasted woods on Mountain or in Vale,
Down to the veins of Earth, thence gliding hot
To some Caves mouth, or whether washt by stream
From underground) the liquid Ore he dreind
Into fit moulds prepar'd; from which he formed
First his own Tooles; then, what might else be wrought
Fusil or grav'n in mettle. (11.564-573)

Unlike the fallen angels, who invasively mine the earth for their ore, this Son of Man "labours" with "two massie clods of Iron and Brass" that were "found where casual fire/Had wasted woods, had "glid[ed] hot/To some Caves mouth" or were "washt by stream/from underground." These relatively shallow mining methods, compared to the deep excavations of Satan's pioneers, require minimal extraction, suggesting that they are not engaging in an exploitative activity contrary to God's laws. The fact that the ores they find "glid[e]" and are "washt" to the surface of the earth suggests that this mineral fruit represents God's bounty to them, an inverse instance of the edible fruit in Eden that is so plentiful that Adam and Eve simply eat from what falls on the ground. The speaker's description of the forger's process of "drein[ing] the "liquid Ore" into "fit moulds prepar'd" to make his "Tooles" is relatively neutral despite the speaker's judgment

against the Sons of Art. Fire and the arts that depend on it seem to be less indicative of sin than the intent to which such substances and art are used.

Satan, who “perverts best things/To worst things abuse” (4.202-3), misuses the creations of God. During the Council of Pandemonium, the fallen angels misinterpret the purpose of refining fire, which is to temper or soften their own hardened, disobedient substance into something more yielding to the authority of God. Instead, their debates concerning how best to transform their “torments” into potent “elements” invoke a sinister politicization of what was intended as a means of refining the soul. For instance, Satan schemes to turn their “tortures into horrid arms/Against the Torturer” (2.63-4) by transforming fire into ammunition to attack Heaven. On the other extreme, Mammon and Belial advise against war and instead argue for the likelihood that they will “conform[...]/In temper and in nature” to the “fierce heat” of the fire (2.217-9). While they affirm the strength of Hell’s fires to change their substance, they do not have the wherewithal to treat the fire as a “trial by contrary” as Guyon would. Rather, they simply change into the contrary force.

Satan’s ambition to outdo God the Father by artificially recreating the effects of God’s thunder with gunpowder formed from the “originals” of creation, sulphur and nitrate, found in heaven’s soil, is reprehensible because it thwarts the ends of art. Satan’s fault lies in informing his legions of fallen angels that “this continent of spacious Heav’n” is “adornd” (6.474) only superficially; its various features, like those of Hell, “grow/Deep under ground” from “materials dark and crude,/Of spiritous and fierie spume” (6.477-79). Satan deploys this information to persuade the fallen angels that the shared material origins of Heaven and Hell argue their equality in power and authority. But for Milton,

the goodness of matter, whether heavenly or hellish, is unquestioned. In misusing the information regarding the material continuity between Heaven and Hell, Satan renders an otherwise good substance into an evil one through his evil intention to attack God's armies with gunpowder.

The mining that Satan's troops conduct on the battlefields of Heaven to extract the components of gunpowder resembles the metallic processing in Hell in terms of its processing of the raw materials found underground; but the narrator describes the process as a "suttle" (6.513) rather than a "wondrous" art, suggesting that Milton does not appreciate it.⁶³ Intent on producing gunpowder, Satan's "innumerable hands" (6.508) "turned/Wide the Celestial soile" (6.509-510) and "found," "mingled," "concocted and adusted" (6.513-4) "Sulphurous and Nitrous Foame" (6.510) into the "blackest grain" (6.515) of gunpowder. The "nitrous foame" to which Milton refers describes the chemical compound of saltpetre, an integral component of gunpowder, which contains a 6:1:1 ratio of saltpetre, sulphur, and charcoal.⁶⁴ Commonly unearthed by "petremen" under dovecotes, stables, barns, and outhouses—common areas of "waste-soaked earth"—saltpetre, or potassium nitrate, is a chemical by-product of animal and human excrement.⁶⁵ The speaker's attitude to this art is negative not because it processes waste products, which constitute according to Satan the "originals" of Nature, but because it is used to act out evil intentions.

The extraction of saltpetre in Heaven, however much it resembles the processes of mining and refining in hell, is oriented differently. Rather than build infrastructure that dares to rival Heaven's, an architectural imperative that attempts to mimic the ascendancy of Heavenly ethereal substance in the vertical alignment of its manufactures,

gunpowder propels shot (and Satan) laterally, a spatial movement that asserts the orientation or intention of a person or thing. The “deep-throated Engines” that “belcht” (6.586) and whose “entrails tore, disgorging foule/Thir devilish glut” (6.588-9) at first appear to be operating according to a Galenic regime of purgation. However, they purge not excrement, but “chained Thunderbolts” and Iron Globes” (6.589-90), whose “level’d” (6.591) orientation differs from the “downward purg[e]” (7.237) that characterizes the excretion of the universe, from the excretion involved in creation to the expulsion of the fallen angels from Heaven. Rather, the engines single-mindedly propel things laterally through space, just as “the strong rebuff of som tumultuous cloud/Instinct with Fire and Nitre hurried [Satan]/As many miles aloft” (2.937-9) on his way to earth. Propulsion, unlike expulsion, does not discriminate between good and bad; rather it perpetuates a particular orientation to the exclusion of all others.

The presence of excrement in Heaven, presumably a highly refined place given its proximity to the sun, would seem to unravel the speaker’s explanation of angelic waste matter in Book 5 as the highly refined excrement of sweat, which “transpires/Through Spirits with ease” (5.438-9). The presence in Heaven of excrement of a less refined type than sweat therefore points to what Rogers and Schoenfeldt have identified as a tension between the monistic and digestive universe, a kind of material theodicy of excrement that makes one to wonder how waste matter can possibly exist in a universe where everything is essentially good and tends toward an increasingly refined state.⁶⁶ This tension, however, is necessary because Milton does not want to resolve matter into pure and impure, a degree of certainty reserved for the extra-earthly and superhuman realms of Heaven, as in when the Son describes to the Father a Heaven free from devilish

influence, when his “Saints unmixt, and from th’impure/Farr separate” shall “sing/Hymns of high praise” (6.745-6). Such a clear-cut division between pure and impure in the human realm would obviate the need for free will and the ethical exercise of choice necessary to engage free will.

A means of “measuring things in Heav’n by things on Earth” (6.893), Raphael’s description of the war in Heaven emblemizes the tension between a mixed and unmixed universe by following the representational logic of the “corporal forms” he introduces in Book 5, which “express [spiritual forms] best” (5.5.74). This description of the war in Heaven and the satanic manufacturing that takes place there occurs in the context of Raphael’s extended conversation with Adam, providing a “terrible example” that Raphael uses to illustrate to Adam the “rewards of disobedience” (6.910). We know that Raphael is explaining the battle for Adam’s benefit when he compares parenthetically to its earthly referent (“[nor hath this Earth/Entrails unlike]”) the raw metallic material that the fallen angels form “Part hidd’n veins digged up” (6.516). Similarly, in Book 5, the speaker expresses uncertainty about digestive separation through his comparison between angelic digestion and alchemical transmutation. A corporal form for the benefit of the implied reader of the poem, the reference to transmutation inserts an element of doubt to the comparison by stating that the “empiric alchemist/can turn, *or holds it possible to turn*” ores into gold (4.440-41, emphasis mine). The very existence of corporal forms in poetry presumes that such conversion is not possible in the human realm; rather, the intertwined nature of good and evil provides an opportunity for humans to exercise their freely willed obedience to God.

The various instances of mining and metalworking in *Paradise Lost* demonstrate that the acts of knowing and searching for knowledge in the material realm are intrinsically good unless they are thwarted by a person's ill will. The ideal is that everything is good regardless of its identity (even the originals of nature are good, albeit confused). But in an Irenean moral order, impurity exists beside purity. The instances of mining and metalworking, by juxtaposing avarice and diligence in the same image, provide a test of reading and interpretation that organizes the gamut from impurity to purity. This mixed, metallic view of the universe marks such various instances as God's creative spirit, the tutelage of Adam and Eve, and the war in Heaven. In all these instances, the "corporal form" of the metallic arts remains constant, juxtaposing the materiality and the immateriality of phenomena it represents. The same relationship that emerges in Milton's prose works between knowledge and the metallic arts, the ill effects of which are described in terms of an ulcerous body politic, exists in *Paradise Lost*. Like the free search for metals that describes a healthy and intellectually engaged populace, Milton's poetics of "corporal forms" ensures that readers will not privilege the material over the ethereal, but embrace them both as substances necessary to the weighing of good and evil.

¹ John Milton, *Areopagitica* in *The Riverside Milton*, ed. Roy Flannagan (New York: Houghton Mifflin, 1998), 1006. All subsequent citations of Milton's prose and poetry are taken from this edition and will be cited parenthetically in the body of the essay.

² See Book 2 of Edmund Spenser, *The Faerie Queene* in *Edmund Spenser's Poetry*, 1-499, eds. Hugh Maclean and Anne Lake Prescott (New York: W.W. Norton, 1993). All citations of *The Faerie Queene* henceforth will be cited parenthetically in the body of the essay.

³ On the early modern critiques of mining derived from Ovid's *Metamorphosis*, see Carolyn Merchant, *The Death of Nature* (San Francisco: Harper, 1989); for an article that

argues such moralizing views of mining stem not from Ovid, but Arthur Golding's early modern translation of the *Metamorphoses*, see George F. Butler, "Arthur Golding's Ovid and the Mining of Hell in *Paradise Lost*," *Notes and Queries* 51.249 (2004): 27-9.

⁴ I take this distinction between the Augustinian and Irenean or "soul-making" view of ethics in *Areopagitica* from Dennis Danielson, *Milton's Good God: A Study in Literary Theodicy* (New York: Cambridge University Press, 1982), 170. For the view that the Fall initiated Adam and Eve's "ethical cognition," before which moment they were blindly obedient to God, see William Poole, *Milton and the Idea of the Fall* (New York: Cambridge University Press, 2005), 138-40.

⁵ Michael Schoenfeldt, *Bodies and Selves in Early Modern England* (New York: Cambridge University Press, 1998); William Kerrigan, *The Sacred Complex* (Cambridge, MA: Harvard University Press, 1983).

⁶ Milton, *On Education in Poems &c. upon several occasions both English and Latin, &c* (London, 1673), 110.

⁷ Milton, *Areopagitica*, 1006.

⁸ *Ibid.*

⁹ *Ibid.*, 1018.

¹⁰ *Ibid.* *Paradise Regain'd* in *Riverside Milton*, 711-782, 1.460.

¹¹ Stanley Fish, "Driving from the Letter: Truth and Indeterminacy in Milton's *Areopagitica*" in *Re-membering Milton: Essays on the Texts and Traditions*, eds. Mary Nyquist and Margaret W. Ferguson (New York: Methuen, 1988), 246-7.

¹² Milton, *Areopagitica*, 1021. On the quotation from which Milton draws, see *ibid.*, 1021n354.

¹³ *Ibid.*, 1013.

¹⁴ *Ibid.* On the Biblical quotation from which Milton draws, see *ibid.*, 1013n256.

¹⁵ *Ibid.*, 1013.

¹⁶ *Ibid.*

¹⁷ *Ibid.*, 1016.

¹⁸ *Ibid.*, 1021.

¹⁹ *Ibid.*, 1019.

²⁰ For the criticism that Danielson collapses Laudian custom with "religious habit," a tendency that Milton would not necessarily condemn, see Paul Cefalu, *Moral Identity in Early Modern English Literature* (New York: Cambridge University Press, 2004), 166.

²¹ On the visual and material separation between clergy and laity instituted by the Laudians, see David Cressy, *England on Edge* (New York: Oxford University Press, 2006), 135-39. On the censorship of opposition to the Laudian style of worship, see, *ibid.*, 139 and David Norbrook, *Writing the English Republic* (New York: Cambridge University Press, 1999), 75.

²² On the effects of Laudian style on theological discussion in general, see Daniel Smith, 1998, 92.

²³ Milton, *Areopagitica*, 1022.

²⁴ *Ibid.*

²⁵ *Ibid.*, 1019.

²⁶ Milton, *Of Reformation in Riverside Milton*, 876.

²⁷ *Ibid.*, 884.

²⁸ Ibid., 893.

²⁹ Ibid., 894.

³⁰ Ibid., 893.

³¹ Ibid., 894.

³² Ibid., 900.

³³ Ibid., *Areopagitica*, 999.

³⁴ Ibid., 1008.

³⁵ Ibid., 1020.

³⁶ Ibid.

³⁷ Ibid., 1004.

³⁸ Ibid., 1008.

³⁹ My understanding of Milton's monism relies on Stephen M. Fallon (*Milton Among the Philosophers: Poetry and Materialism in Seventeenth Century England* [Ithaca, NY: Cornell University Press, 1991]), who defines monism as a poetic practice and philosophy in which Milton "treats spirit and matter as manifestations, differing in degree and not qualitatively, of the one corporeal substance" (102). For a criticism of Fallon's collapse of first matter and bodily matter in his definition of monism, see Philip J. Donnelly, "'Matter' versus Body: The Character of Milton's Monism," *Milton Quarterly* 33.3 (1999): 79-85. An earlier treatment of the proto-capitalist nature of Milton's monism can be found in Christopher Kendrick, *A Study in Ideology and Form* (New York: Methuen, 1986).

⁴⁰ On the heterodoxy of Milton's "scale of nature," see John Rogers, *The Matter of Revolution* (Ithaca, NY: Cornell University Press, 1996), 110.

⁴¹ Milton, On Christian Doctrine in Riverside Milton, 1556-1201, 1177.

⁴² Ibid.

⁴³ Ibid.

⁴⁴ Ibid.

⁴⁵ Ibid., 1192.

⁴⁶ On Milton's Baconianism and/or experimentalism, see Catherine Gimelli Martin, "'What if the Sun Be Centre to the World?': Milton's Epistemology, Cosmology, and Paradise of Fools Reconsidered," *Modern Philology* 99.2 (2001): 231-65; Karen L. Edwards, *Milton and the Natural World* (New York: Cambridge University Press, 1999); and Joanna Picciotto, "Reforming the Garden: The Experimentalist Eden and *Paradise Lost*," *English Literary Renaissance* 72 (2005): 23-78. For an older view that Milton used "medieval science" not contemporary to the seventeenth century climate of Baconianism, see Kester Svendsen, *Milton and Science* (Cambridge: Harvard University Press, 1956) and Lawrence Babb, *The Moral Cosmos of Paradise Lost* (East Lansing, MI: Michigan State University Press, 1970). For a corrective to this view, see Fallon and Rogers. Both argue that Milton's vitalist metaphors, relying on alchemical and metallurgical processes, demonstrated Milton's participation in the Vitalist thought popular among Republican circles before and during the Civil War.

⁴⁷ Poole, "Milton and Science: A Caveat," *Milton Quarterly* 38 (2004): 18-34.

⁴⁸ Ibid., 28.

⁴⁹ Ibid.

⁵⁰ See definition 3 of “guiltless, a.,” *Oxford English Dictionary Online*, 2nd. Ed., 1989 <<http://www.dictionary.oed.com>> (20 March 2007).

⁵¹ On chaological theories of God’s creation, see Rogers, esp. chapter 4, and Andrew J. Mendelsohn, “Alchemy and Politics in England 1649-1665,” *Past and Present* 135 (1992): 30-78, 40.

⁵² On Adam’s prelapsarian “touching” of Eve as evidence of Milton’s “equivocal” and “situational” treatment of passion, which in turn demonstrates “the radical inconsistency with which early modern culture confronted the phenomenon of passion” (46), see Schoenfeldt, “‘Commotion Strange’: Passion in *Paradise Lost*” in *Reading the Early Modern Passions*, 43-67, eds. Gail Kern Paster, Katherine Rose, and Mary Floyd-Wilson (Philadelphia: University of Pennsylvania Press, 2004).

⁵³ *Ibid.*, 45.

⁵⁴ *Ibid.*, 46.

⁵⁵ *Ibid.*, 67.

⁵⁶ On Raphael’s misstating of Adam’s views on passion, see *ibid.*, 55.

⁵⁷ On readings of mining as a fallen labor see Aschah Guibbory, (*Ceremony and Community from Herbert to Milton* [New York: Cambridge University Press, 1998]), who describes the mining and architectural labor of hell as a “perverse mirror” (193-4) of Milton’s poetry; for a Heideggerean reading of this fallen labor as the self’s loss of wholeness, see Matthew Jordan, *Milton and Modernity* (New York, Palgrave, 2001); for an ecological reading of mining as a wound in the earth parallel to that created by Adam and Eve’s fall, see Ken Hiltner, *Milton and Ecology* (New York: Cambridge University Press, 2003), 129; for those who see Milton’s apparent dislike of mining as an allusion to the Ovidian injunction against mining, see Merchant; J. Martin Evans, *Milton’s Imperial Epic* (Ithaca, N.Y.: Cornell University Press, 1996), 38; and Harinder Singh Marjara, *The Contemplation of Created Things* (Toronto: University of Toronto Press, 1992), 173-5. For the humanist allegiances that such references to mining reveal, which were taken from humanist metallurgical texts such as Georg Agricola’s *De Re Metallica*, the foremost authority on mining and metallurgy in the period, see Edgar Hill Duncan, “The Natural History of Metals and Minerals in the Universe of Milton’s *Paradise Lost*,” *Osiris* 11(1954): 386-421 and Marjara, 181.

⁵⁸ Kerrigan, 195-6, 219.

⁵⁹ Leonard Barkan, “The Beholder’s Tale: Ancient Sculpture, Renaissance Narratives,” *Representations* 44 (1993): 133-66, 136.

⁶⁰ Milton, *Paradise Lost*, 375n200.

⁶¹ Ann Torday Gulden, “Is Art ‘Nice’? Art and Artifice at the Outset of Temptation in *Paradise Lost*,” *Milton Quarterly* 34.1 (2000):17-24, 19. Like me, she wants to reinvest the category of “art” with a positive meaning, since she sees it in prelapsarian moments such as Eve’s work in the garden. She focuses more on the term “nice” art and doesn’t mention the use of “wond’rous,” a term of praise Milton’s speaker uses to describe mining. See, in contrast, Flanagan’s “Art, Artists, Galileo and Concordances,” *Milton Quarterly* 20 (1986): 103-05, which argues that art in *Paradise Lost* is unambiguously evil because of its association with the “black arts” and dissimulation of the fallen Angels.

⁶² The Riverside Milton's editorial choice of using "found out" instead of "found" has a long editorial history. For a brief overview of this history and the reasoning behind using "found out," which primarily views "found out" as more indicative of a "wondrous Art" because it implies "detect[ing] and obtain[ing] with difficulty" (82), see B.A. Wright, "Book Review: *The Poetical Works of John Milton*," *The Review of English Studies* 8.29 (February 1957): 78-94.

⁶³ On Milton's negative treatment of "suttle" art, see Flannagan, "Art, Artists."

⁶⁴ Richard W. Stewart, *The English Ordnance Office, 1585-1625* (Rochester, NY: Boydell Press, 1996), 81.

⁶⁵ *Ibid.*, 80.

⁶⁶ On the material theodicy posed by the Paracelsian, digestive waste product of "tartar," see Rogers, 133. On the tension between Milton's monistic universe and the digestive processes emblemized by "tartar" and waste (especially digestive), see Schoenfeldt, 145.

Conclusion

*I had rather hear a brazen canstick turned,
Or a dry wheel grate on the axle-tree,
And that would set my teeth nothing on edge,
Nothing so much as mincing poetry.
'Tis like the coerced gait of a shuffling nag.*
Hotspur, 1 Henry 4, 3.1.127-131

In response to the Lord Glendower's boast that, despite being Welsh, as a youth in the English court he had "framed to the harp/Many an English ditty lovely well" (3.1.120-1), Hotspur pronounces in metallic terms his utter hatred for all things lyrical. Preferring to "hear a brazen canstick turned,/Or a dry wheel grate on the axle-tree" rather than listen to "mincing poetry," Hotspur erects a dichotomy between the metallic art of candlestick turning and the literary art of composing verse. While he does not figure himself as a producer in either of these crafts, by positioning himself as an auditor, he invokes the way in which most early modern English people would have experienced both verse and industry: through the theater of the stage and the street.¹ More importantly, however, Hotspur's opposition between poetry and metalworking provides an unexpectedly mundane reversal of a more canonical dichotomy erected between the two in early modern literature through the Ovidian discourse of the Iron Age, which depicts mining and metalworking as exploitative activities that harm the earth and spawn greed in people.² Throughout my dissertation, the mundane details and practices of metalworking come up against a literary discourse that belittles them, be it through

Ovidian allusion or satirical treatments of alchemy. Hotspur's taunt to Glendower emblemizes the way in which metalworking is a kind of anti-poetry that nonetheless asserts its textual and semiotic nature in both literary and non-literary texts through allusions to the technical skill required to read metals. While Hotspur does not claim literally to read metals, his brief allusion to the phenomenal world that metalworking shares with the theatrical arts confers upon the "brazen canstick" the status of sign—a sign that derives meaning from its imbrication within a wider network of technique of both the metallic and the poetic variety. Hotspur's invocation of the screeching "canstick" to signify his denial of the legitimacy of the overwrought and "coerced gait" of poetry asserts a productive metaphors of metal that in diverse early modern texts finds its expression in the virtue of mettle/metal, which predicts the efficacy of the self in action.

The connections between literature and the metallic arts that I draw from literary instances of the pun between metal and mettle build on recent work in science studies that attempt to account for the cognitive content of metaphors in science. James Bono, for example, describes metaphor as not just a rhetorical category, but a cognitive process that "depend[s] upon the primacy of bodily experience of the physical world."³ Drawing from the work of Lakoff and Johnson and Bruno Latour, Bono argues that the experience of embodying the world as a "hybrid, mixed 'thing'" at the intersection of the "natural and the cultural" entails "relat[ing . . .] through the other, to self and the world."⁴ The reliance of the category of mettle on the metallic arts for its intelligibility is therefore an

example of the self relating to the world through technology. I would extend that relation as being mediated through a literary discourse that both shuns and idealizes the metallic other that is at once other and self.

The notion that “relating to the world” is constitutive of the self implies an ontological equivalence between self and world. The attributes of character and virtue that early modern English writers were able to extract from both the figurative and actual processing of a metal—as I describe in all four chapters—is authorized through historical and contemporary theoretical warrants that describe text and nature, subject and object, as coexisting within a larger web or network of meaning. On the one hand, the early modern notion of the “Book of Nature” understands nature to be a text of nature intertwined with the “divine text constituted by the logos, the creative world of God.”⁵ Such an intertwining presumes, according to William B. Ashworth, the “emblematic world view” of early modern natural history, in which the natural world and its objects were not neutral, but endowed with divinely inscribed significance.⁶ According to Bono, natural historical knowledge was valuable insofar as it “uncovered meanings in the text of nature that forged deeply resonant links with mankind’s moral, cultural, cosmological, and symbolic universes.”⁷ As natural historical features of the subterranean landscape, metals naturally form a part of the book of nature, and attempts to unearth metals from the womb of the earth can be construed as illustrative of the process of uncovering and deciphering the meaning of the text of nature, as in John Milton’s *Areopagitica* and other prose tracts, when mining and metalworking figures the free pursuit of knowledge. Things are connected ontologically to humans, therefore, through the web of narrative within which things and humans alike are placed according to the divine book of nature.

In a more contemporary vein, the work of sociologist of science Bruno Latour considers the interaction between subject and object to be mutually defining insofar as they coexist within the same network of people, things, and resources. Drawing on the work of philosopher Michel Serres, Latour, in his introduction to *We Have Never Been Modern*, describes Steven Shapin and Simon Schaffer's account of the air-pump as an example of an inanimate object, rather than a human subject, speaking.⁸ Described as a "quasi-object," the air-pump's negotiation of scientific controversies points to an ontological equivalence between people and things. In light of the notion that nature is a text, Latour's notion of network becomes deeply textual in the early modern period because of the Biblical warrant that nature was a book that emblemized the unity of God. But Latour's focus on quasi-objects displaces the master narrative of the book of nature. Drawing from Serres' understanding, through the concept of *homo faber*, that technique is the origin of the human relation to objects,⁹ Latour's quasi-objects provide a provisional and practical understanding of the way in which people and things interact. As the warrant for the ontological connection between humans and things, technique, or Aristotelian techne, as I have been invoking through the dissertation, disrupts Martin Heidegger's Romantic view of technology, and the Ovidian distinction between the golden and iron ages, as a fallen state before which a wholistic plenitude existed.

The literary discourse of metals falls short of the actual practice of the metallic arts in early modern England by vilifying it, which allows for the semiotic potential of metals to emerge through a discourse of technical skill that forges an ontological link between metals and people. In *1 Henry 4*, Hotspur, for instance, objects vocally to the "holiday and lady terms" (1.3.54) of the courtier who, though assigned by King Henry to

collect prisoners of war, objects to gunpowder in the Ovidian terms of the Iron Age, stating that “it was great pity, so it was,/This villainous saltpeter should be digged/Out of the bowels of the harmless earth” (1.3.58-60). This moment emblemizes the way in which the very mining processes shunned by the courtier as exploitative are necessary for the House of Lancaster to secure its claim of sovereignty. As I described in chapter three, Hotspur’s epithet of “gunpowder,” coupled with a thematic insistence on the technology of weaponry in many of Shakespeare’s plays, illustrates the way in which the base metal of iron is central to the production of English mettle, a point that Mary Floyd-Wilson has elegantly shown in terms of the differences between English and French mettle in *Henry 5*.¹⁰ Similarly, in the *Merchant of Venice*, Portia famously hijacks the metallic correspondent of her father’s “meaning” (2.1.31)—the lead casket—to mobilize her own will toward her desired object, Bassanio. I would argue that low-grade mettle/metal is necessary for the production of poetry as well.

The Ovidian discourse of the Iron Age presumes that mining and metalworking is exploitative because it masters the all-giving earth with humanly derived technique. But as the age of technology, the Iron Age warrants the transformations that occur throughout the *Metamorphoses* and provide the conditions under which Ovid composes his poem. Similarly, Milton relies on the fallen language of poetry to describe godliness. In Arthur Golding’s translation of the poem, Prometheus tempers a seed in the earth, from which spring humans, who then proceed to live through all the metallic ages. Metalworking is the condition of possibility for poetry in the sense that it is the first art, the first imitation of the ability of nature to provide freely for the inhabitants of the earth. In this way, the

Iron Age is representative of the condition of being through technology that Michel Serres describes as the fundamental way in which humans relate to their world.

Returning to my starting point for the dissertation, Hamlet's "muddy-mettled" state, I want to suggest that low-grade mettle was actually necessary for the composition of poetry. Interestingly, base mettle means one is more susceptible to "copy" the objects of others, a skill necessary in a period when authorial originality stemmed from the ability to imitate classical authors with panache. In *Julius Caesar*, for example, Anthony describes Lepidius, whose "corporal motion is govern'd by [Anthony's] spirit" (4.1.33) as a "barren-spirited fellow; one that feeds/On objects, arts, and imitations,/Which, out of use and stal'd by other men,/Begin his fashion" (4.1.36-9). Similarly, Hamlet's muddy-mettle keeps him on the level of fiction, representation, and symbol. For instance, the story of the fall of Troy that he asks the visiting player to recite was recommended by Erasmus as an ideal passage to practice achieving *copia*, the rhetorical skill of creating rich and varied variations on a theme.¹¹ The focus of such rhetorical exercises, which someone of Hamlet's education and disposition doubtless performed, was less to emulate themes through one's conduct than to dilate and summarize them in one's writing and speech. Hamlet, collapses the visiting player's acting on stage—his representation of emotion and action—with Hamlet's own desire to act in the world. By addressing his constitutional inability to enact revenge with the Mousetrap play, Hamlet welds the world of fiction with the world of politics. In the course of my dissertation, metal/mettle is a faculty of action that in its refined states does not spur the creation of poetry; rather, muddy-mettle spurs the creation of poetry insofar as it encourages copying the spirits of other people. So this is a model of poetic creation that relies not on the notion of conjured

spirit or genius, as Stephen Greenblatt has argued,¹² but on the notion of crafting and imitating the spirit of others.

¹ On the “sonic distinctiveness” of the metalfoundry district of Lothbury, famous especially for producing screeching sounds of candlestick turning, see Bruce R. Smith, *The Acoustic World of Early Modern England: Attending to the O-Factor* (Chicago: University of Chicago, 1999), 54-5.

² For the view that the shift in Ovid’s *Metamorphoses* from the Golden to the Iron Age “introduces a paradoxical element into his mythical history,” such that there is a “disjunction between metals as metaphoric markers of historical decline and metals in actual use” (70), see Anthony Miller, “Ben Jonson and “the proper passion of Mettalls,” *Parergon* 23.2 (2006): 57-72.

³ James J. Bono, “Why Metaphor? Toward a Metaphorics of Scientific Practice, in *Science Studies: Probing the Dynamics of Scientific Knowledge*, 215-34, edited by Sabine Maasen and Matthias Winterhager (Bielefeld: Transcript, 2001), 218-9.

⁴ *Ibid.*, 222-3.

⁵ *Ibid.*, *The Word of God and the Languages of Man*. v. 1 (Madison: U of Wisconsin P, 1995), 171.

⁶ William B. Ashworth, Jr. “Natural History and the Emblematic World View,” in *Reappraisals of the Scientific Revolution*, edited by David C. Lindberg and Robert S. Westman (New York: Cambridge University Press, 1990). For a discussion of the view of knowledge implied by Ashworth’s understanding of the “emblematic world view,” see Bono, *Word of God*, 174-5.

⁷ Bono, *Word of God*, 175.

⁸ Bruno Latour, *We Have Never Been Modern* (Cambridge: Harvard University Press, 1993). On the instructiveness of Michel Serres and Bruno Latour’s work for understanding the relation between early modern material culture and the writing of history, see Julian Yates, “What are ‘Things’ Saying in Renaissance Studies?” *Literature Compass* 3.5 (2006): 992-1010. On the politics of knowledge illustrated by the seventeenth-century air-pump, see Steven Shapin and Simon Schaffer, *Leviathan and the Air-Pump* (Princeton: Princeton University Press, 1989).

⁹ Michel Serres. *Hermes: Literature, Science, Philosophy*, edited by Josue V. Harari and David F. Bell (Baltimore: Johns Hopkins University Press, 1982), 91.

¹⁰ Mary Floyd-Wilson, “English Mettle,” in *Reading the Early Modern English Passions*, 130-46, eds. Gail Kern Paster, Katherine Rowe, and Mary Floyd-Wilson (Philadelphia: University of Pennsylvania Press, 2004).

¹¹ Magreta de Grazia, “Hamlet’s Thoughts and Antics,” in *Early Modern Culture: An Electronic Seminar*, 2001 <<http://www.eserver.org/emc/1-2/degrazia.html>> (17 February 2007).

¹² Stephen Greenblatt, “What is the History of Literature?” *Critical Inquiry* 23.3. (1997): 460-81.

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